ARMY RESEARCH LABORATORY

The Effect of Future Forces Warrior Planned Sensor Offset on Performance of Infantry Tasks: Limited User Evaluation

by Elizabeth S. Redden, Daniel D. Turner, and Christian B. Carstens

ARL-TR-3764 **April 2006**

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Elizabeth S. Redden, Daniel D. Turner, and Christian B. Carstens
Human Research & Engineering Directorate, ARL

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14. ABSTRACT

This study was conducted to evaluate the effect of offsetting the sensors in digital night vision goggles (NVGs) (thermal and image intensification [I^2] sensors) from the eye. In addition to the digital prototype goggles, an enhanced NVG (ENVG), which optically combined thermal and I^2 capabilities, was used as a baseline device. The experiment was executed over a period of a week with five groups of Soldiers, each of which contained six Soldiers acting as participants. Soldiers received familiarization training about the two prototype night vision devices (NVDs) and the baseline device, and they were briefed at the start of each exercise to explain what was required of them during the event. The exercises included a wide range of infantry activities to enable comprehensive assessment of features. These included grid location exercises, individual movement techniques (IMT) course trials, cross-country woodland patrols, target laser trials, and aim light mounting trials. The experiment was conducted in October 2005 during hours of darkness at various sites in Fort Benning, Georgia.

The prototypes did not perform as well as the baseline in this study on the dismounted tasks. Soldiers preferred the baseline overwhelmingly to either of the prototypes because with the baseline goggle, they could see terrain features much better for navigation and walking, for firing a laser at targets, and for performing close tasks than they could with the prototypes with the offset sensors. The prototype goggles caused the Soldiers to experience problems such as eyestrain and disorientation. It may be that the use of NVGs with offset sensors will cause Soldiers difficulty when they perform dismounted tasks. However, this conclusion cannot be stated categorically because the devices with offset sensors used in this study were prototypes and had other problems that could also have impacted their performance.

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1. Introduction

1.1 Statement of the Problem

Results from the U.S. Army Infantry School's Soldier Battle Lab's "Own the Night" experimentation and from the U.S. Army Research Laboratory's (ARL) experimentation conducted by its Human Research and Engineering Directorate indicate that the placement position of image intensification (I^2) and other vision sensors on the Soldier's helmet has a direct impact on Soldier task performance. Infantry Soldiers commented during the "Own the Night" experiments that the placement of sensors on top of their helmets resulted in their having significant difficulty in determining where the ground is when they were walking, and for some, this resulted in nausea and disorientation. A test of prototype enhanced night vision goggles (ENVGs) conducted by ARL indicated that Soldiers had difficulty moving through buildings with offset sensors on top of their helmets (Bonnett, Redden, & Carstens, 2005). ARL's "sensor" viewpoint offset experiment with grenade throwing indicated that placement of sensors on the side of the helmet resulted in increased errors (CuQlock-Knopp, Myles, Malkin, & Bender, 2001). These results indicate that it is important to understand the effects of sensor offset on Soldier mobility and dexterity (i.e., close tasks).

1.2 Objective

The primary objective is to assess the impact of the planned Future Forces Warrior (FFW) sensor location on Soldier dexterity and mobility.

1.2.1 Grid Location Exercise

Assess the impact of the Soldier Mobility and Rifle Targeting System (SMaRTS) and brassboard design (sensor placement) on the Soldiers' abilities to accurately touch a small object within arm's length.

Record the Soldiers' overall ratings of ease of completing the task with baseline and two candidate systems.

1.2.2 IMT Mobility Course Trials

Assess the impact of the SMaRTS design on negotiating selected obstacles on an individual movement techniques (IMT) course.

Record the Soldiers' overall ratings of the IMT course negotiation with the baseline and the SMaRTS.

1.2.3 Cross-Country Woodland Patrol

Assess the impact of the SMaRTS design on the Soldiers' ability to traverse a short but rugged wooded course.

Record the Soldiers' overall ratings for ease of traversing a wooded course with baseline and SMaRTS.

1.2.4 Firing a Laser at Targets

Assess the impact of the SMaRTS and brassboard design (sensor placement) on the Soldiers' ability to accurately "lase" (i.e., emit coherent light at) 25-, 50-, 100-, and 150-meter targets.

Record the Soldiers' overall ratings of ease of "lasing" targets with baseline and two candidate systems

1.2.5 Mount and Dismount Aiming Light to Weapons

Assess the impact of the SMaRTS and brassboard design (sensor placement) on the Soldiers' abilities to mount and dismount aiming lights on the M4 carbine.

Record the Soldiers' overall ratings of ease in mounting and dismounting weapons sights with the baseline and two candidate systems.

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2. Method

2.1 Overview

Target audience Soldiers performed a variety of infantry dexterity and mobility tasks while wearing the SMaRTS and the FFW brassboard system. Their performance with these systems was compared to their baseline performance using the optically fused ENVG. The tasks and performance measures are shown in table 1. The brassboard prototype was insufficiently rugged for the woodland patrol lane and the mobility course.

Table 1. Tasks and performance measures.

Task	System	Performance Measure
Grid Location Exercise	ENVG, brassboard, and SMaRTS	Distance that the reach is offset from the center of the object
IMT Mobility course	ENVG and SMaRTS	Time and errors to negotiate obstacles including a zigzag, a tunnel, a hill, stairs, a window, and heavily wooded terrain
Cross-Country Woodland Patrol Course	ENVG and SMaRTS	Time and errors
Laser Aiming with AN/PAQ-4 infrared aiming light	ENVG, brassboard, and SMaRTS	Vertical and horizontal distance from center of target
Mounting and dismounting the AN/PAQ-4 to the M4	ENVG, brassboard, and SMaRTS	Time and errors

2.2 Participants

Thirty Soldiers (six different Soldiers per night) from the 75th Ranger Regiment's Ranger Indoctrination Program (RIP) participated in the experiment. These Soldiers came from varied military occupational specialties (MOSs) and were representative of the force.

The Soldiers completed this experiment using the candidate systems mounted on the FFW helmet (brassboard), advanced combat helmets (ACH) provided by the experiment director (SMaRTS), and their individual helmet (ENVG baseline). They wore their battle dress uniform, and they carried a training device simulating the M4 carbine.

2.2.1 Pre-Test Orientation and Volunteer Agreement

The Soldiers were given an orientation about the purpose of the study and their participation. They were briefed about the objectives and procedures for each experiment, as well as the equipment they were required to use throughout the investigation. All tasks planned for this experiment were a normal part of the infantry job. Soldiers were also told how the results would be used and the benefits the military can expect from this investigation. Any questions the subjects had regarding the study were answered. In addition, the volunteer agreement affidavit was explained and its contents verbally presented. It was made clear that Soldier participation in the experimentation was voluntary. The Soldiers were informed that if they chose not to participate, they could convey that choice privately to the experiment manager. The experiment manager would then inform that Soldier's unit supervisor, without elaboration, that the Soldier did not meet experimental criteria. The Soldiers were then given the volunteer agreement affidavit to read and sign if they decided to volunteer. All Soldiers signed the affidavit.

2.2.2 Medical Review and Screening

At the outset of the experiment, the investigators asked the Soldiers if any of them had a medical profile or history that would jeopardize them if they participated in the study. Soldiers were then asked to complete a medical status form.

2.2.3 Demographics

Demographic data were taken for each Soldier. Data concerning their Army experience and their experience with night vision devices were included in the demographic questionnaire.

2.3 Instruments and Apparatus

2.3.1 Standard and Candidate Item Descriptions

2.3.1.1 ENVG (baseline goggle)

This ENVG's design philosophy was to provide a small goggle that can be hand-held or mounted on a combat helmet. The ENVG completely integrates an infrared camera and an I^2 system into a single monocular. The monocular itself does not contain batteries but derives power from a helmet-mounted battery pack (when helmet mounted) or a clip-on battery pack (when hand held). The resultant system (monocular, helmet mount, helmet-mounted battery pack) is compact, with a weight of approximately 5.2 pounds. The primary goal of this design is "optical fusion in a small package." Equipment data are presented in table 2.

Table 2. Device A (baseline goggle) equipment data.

System	Specification
Forward Projection	128 mm (from eye)
Total System Weight (including helmet mount, batteries, cables, etc.)	5.187 lb (4-cell battery pack, lithium batteries)
Battery Type Operating Life (one set of batteries)	Based on using "AA" lithium cells >0°C: 8 hours (4-cell battery pack)
Image Intensifier	
Photocathode Sensitivity	2,000 microamps per lumen
Signal-to-Noise Ratio	25
Luminance Gain	50,000
Halo	0.9 mm
Center Resolution	64 line pairs per millimeter (lp/mm)
High Light Resolution	36 lp/mm
Thermal Camera	
Array Size	320 x 240
Pixel Size	25 microns
Field of View	19.2°(H) x 14.4° (V) (24 degree diagonal)
Resolution (multi-resolution time domain)	Less than a line form by two points on a graph: 0.08°C at 0.05 cycles per milliradian (cy/mr) 0.59°C at 0.30 cy/mr

Figure 1 shows the ENVG worn by a Soldier.

Figure 1. Soldier wearing ENVG.

2.3.1.2 SMaRTS Helmet-Mounted Sensor System

The SMaRTS (figure 2) is designed as a helmet-mounted fused, multi-spectral sensor system for infantry Soldiers. The system contains visible and near infrared (VISNIR) (I^2 waveband) and long-wavelength infrared (LWIR) (thermal, also called the helmet-mounted infrared camera, or HMIC) sensors mounted in a dual-aperture, vertical orientation in the center of the helmet. The imagery is viewed on a high-resolution, non-see-through, monochrome helmet-mounted device (HMD) which can be adjusted to be viewed by the left or right eye. The specific sensors being used are an off-the-shelf thermal sensor and a conventional (generation III) I^2 sensor that consists of a photomultiplier tube coupled to a commercial charge-coupled device sensor. The display is a monochrome super-extended graphics array display. Kaiser Electro-Optics is the prime contractor for the design and fabrication of the SMaRTS. The SMaRTS is intended to mount on the ACH. This visual sensor is offset from the eye but provides visual enhancement. The multi-phased program, funded by the Night Vision and Electro-optic Sensors Directorate of the U.S. Army Communication Electronics Research and Development Engineering Center integrates sensors that operate in the same wavelengths as the ENVG. Fusion is accomplished with a simplified analog additive scheme that allows fading between the two sensor sources. Additional SMaRTS information is given in appendix A.

Weight breakdown for SMaRTS is shown in table 3.

Figure 2. SMaRTS.

Table 3. Weight breakdown, SMaRTS.

Weight	7.6 lb (including medium ACH)
Weight breakdown	Modular integrated communications helmet (MICH): 3.35 lb Sensor module (including battery): 4.35 lb Battery: 0.65 lb

2.3.1.3 Future Forces Warrior (FFW) brassboard

The FFW headgear brassboard system (figure 3) was assembled in early 2005 for the purpose of evaluating the performance of the single-aperture, fused, multi-wavelength sensor concept. Because of the configuration (helmet + backpack electronics), it is intended as a performance evaluation platform in controlled environments *and should not be considered for use in the field*. Figure 3 shows the configuration of the brassboard system.

The helmet subsystem includes sensors (LWIR, and VISNIR or I^2) that operate in the same wavelengths as the ENVG, fused with sophisticated digital fusion, and optics for combining and focusing images from the sensors. The specific sensors being used are the same thermal sensor as used in SMaRTS. A sensor-optics assembly is attached to the front of the helmet. Common aperture optics were used with the two sensors that eliminate sensor-to-sensor parallax issues that are seen with dual-aperture systems. A liquid crystal display (LCD) module is attached below this assembly, which can be positioned over the user's eye. The electronics for driving the LCD display module can be seen on the back side of the helmet. The remainder of the electronics are situated in a chassis stowed in the user's backpack. This visual sensor is offset from the eye but provides visual enhancement. Additional brassboard information is presented in appendix B.

Figure 3. Brassboard system.

2.3.2 Infantry Task Courses

The following section provides a description of the environments used for this study.

2.3.2.1 Grid Location Exercise

The purpose of this exercise was to document any systematic directional bias in hand-eye coordination caused by the offset of the I^2 and thermal camera. The exercise was selected to provide the Soldiers with the opportunity to look through the device and touch an object within arm's reach. The center of a grid was used as the target object, and the grid squares around the center were used to show where the Soldiers actually touched. The grid target is a 2-foot by 2-foot upright board laid in 1-inch-square grids (see figure 4). There is a hole, approximately 1/2 inch in diameter, in the middle of the target. The board is backed with a thermal zeroing target so that the center target emits heat.

	-4	-3	-2	-1	0	1	2	3	4
4									
3									
2									
1									
0									
-1									
-2									
-3									
-4									

Figure 4. Grid location board.

2.3.2.2 IMT Mobility Course

The IMT course provides a methodology for assessing IMT woodland performance that enables control, standardization, and repeatability. The course design requires Soldiers to use virtually all tactical maneuvers and IMTs that are non-military operations on urbanized terrain (MOUT). The course is situated in a field, with 10 obstacle areas. It requires Soldiers to execute a variety of individual movements and to assume a variety of positions while they maneuver through, over, under, and around obstacles. Obstacles include (a) pipe crawl area, (b) zigzag area, (c) 2-foot jump, (d) hill, (e) low crawl area, (f) combat roll station, (g) high crawl area, (h) kneeling firing position station, (i) high wall, and (j) prone firing position stations. Appendix C shows a sketch of the course.

2.3.2.3 Cross-Country Woodland Patrol Course

The cross-country course requires the Soldier to move along a controlled, clearly marked route approximately 200 meters long by 20 meters wide, through forested terrain while accompanied by a data collector. The lane is marked with white tape on either border. It requires the Soldiers to traverse heavily wooded areas, as well as areas that require the Soldier to crawl under and climb over obstacles, depressions, and other difficult terrain.

2.3.2.4 Target Laser Station

A short non-firing aiming light range was established for this experiment with "E" type silhouette targets set at 25, 50, 100, 150 meters. The Soldiers used an M4 simulated rifle and the AN/PEQ-4 aiming light to aim at the targets.

2.3.2.5 Mount/Dismount Aiming Light Station

This station consisted of a table upon which an M4 and AN/PAQ-4 laser aiming device was laid. Timed trials were conducted to measure the amount of time required by the Soldiers to mount and dismount an AN/PEQ-4 laser aiming device on a weapon while they wore each of the devices.

2.3.3 Questionnaires

Questionnaires were designed to elicit Soldiers' opinions about their performance and experiences with each of the systems. The questionnaires were designed to enable Soldiers to rate the devices on a 7-point semantic differential rating scale ranging from "extremely good/easy" to "extremely bad/difficult." Questionnaires were administered to each Soldier at the completion of each of the trials with each of the devices and at the completion of the training course. A questionnaire that also elicited rankings of the devices on the tasks conducted during the evaluation was administered at the completion of the experiment. Detailed questionnaire results are shown in appendix D.

2.4 Procedures

2.4.1 Training

The requested Soldiers were in an MOS that requires the use of night vision devices (NVDs), performance of mobility and portability maneuvers (movement to contact and assault maneuvers), and movement as a dismounted element. No specialized experience was required. However, the Soldiers were shown how to negotiate each of the courses safely, trained in specific procedures as required, and given the opportunity to walk through the courses at a slow speed to better familiarize them with the courses, as well as reduce Soldier risk and the learning curve during actual course execution. They were also given specialized training about each of the prototype systems and the baseline goggles.

Before the first training presentation, experiment Soldiers received a roster number, which was used to identify them throughout the evaluation. A representative from the FFW program trained the Soldiers in the use of the candidate systems (SMaRTS and brassboard). Evaluation directorate personnel trained the Soldiers to use the baseline system. Training focused on the donning, doffing, and operation of the NVDs. Within each training session, the Soldiers had the opportunity for "hands-on" interaction with the NVDs. Upon completion of each training

session, the Soldiers were given a questionnaire designed to assess their perception of the training adequacy. Questions about system operating procedures, level of detail presented, adequacy of training aids, and length of training were asked.

2.4.2 Grid Location Exercise

This exercise was conducted outdoors. Soldiers were assigned NVDs according to the matrix in table 4. They wore an eye patch over their unaided eye. The Soldier stood at arm's length from the grid target board facing away from the board. The Soldier had his hands at his sides. At the command from the data collector, the Soldier turned around and raised his preferred hand to touch the center grid with his index finger. The Soldier was instructed to touch the target immediately, without hesitation, as soon as he turned around. The data collector recorded the grid indicated by the Soldier. The Soldier then faced away from the grid board; the data collector shifted the board a few inches to the left or right. This procedure was repeated until the Soldier attempted to touch the target nine times with each NVD. It was planned that three of the attempts were to be done with I^2 only, three attempts were to be done with thermal only, and three were to be done with the Soldier's preference of I^2-thermal mix. After the first iteration, it became apparent that in order to change the brassboard from I^2 to thermal or mix, the Soldier had to return to the computer indoors, remove the system from his head and back, hook the system to the computer, and wait for the contractor to change the setting. The amount of time required to perform this would have prevented completion of the other tasks planned for the night. Since the brassboard system had a common aperture and so much time was required to change the mix, the contractor and evaluation directorate decided to only perform the grid location task with the I^2 mix on the brassboard. After the first day of the evaluation, the thermal component of the SMaRTS, which was being used for the grid location task, broke so the sample size for the thermal and mix on the SMaRTS is extremely small. After each iteration, the Soldier completed a questionnaire regarding his experience with the NVDs.

Table 4. Grid location treatment assignment.

Roster	Iteration		
	1	2	3
1	SMaRTS	BB	ENVG
2	BB	ENVG	SMaRTS
3	ENVG	BB	SMaRTS
4	SMaRTS	ENVG	BB
5	BB	SMaRTS	ENVG
6	ENVG	SMaRTS	BB
7	ENVG	SMaRTS	BB
8	BB	SMaRTS	ENVG
9	SMaRTS	ENVG	BB
10	ENVG	BB	SMaRTS
11	SMaRTS	BB	ENVG
12	BB	ENVG	SMaRTS
13	ENVG	BB	SMaRTS
14	SMaRTS	BB	ENVG
15	BB	SMaRTS	ENVG
16	ENVG	SMaRTS	BB
17	BB	ENVG	SMaRTS
18	SMaRTS	ENVG	BB
19	BB	ENVG	SMaRTS
20	SMaRTS	ENVG	BB
21	ENVG	SMaRTS	BB
22	BB	SMaRTS	ENVG
23	ENVG	BB	SMaRTS
24	SMaRTS	BB	ENVG
25	SMaRTS	ENVG	BB
26	ENVG	BB	SMaRTS
27	SMaRTS	BB	ENVG
28	BB	ENVG	SMaRTS
29	ENVG	SMaRTS	BB
30	BB	SMaRTS	ENVG

2.4.3 IMT Mobility Course

Soldiers initially walked through the course (see appendix C), and each obstacle and position was explained before they ran the first record trial. In addition, all Soldiers completed one familiarization trial wearing their uniforms, standard fighting loads, and carrying their assigned weapons. A description of each event and instructions for executing the event are provided next.

- Starting Point. The starting point is clearly marked with a white line that spans the width of both lanes on the course. The course requires the Soldier to begin in the upright standing position with his weapon held at "port arms." Upon the command "go" from the data collector, timing for the trial begins and the Soldier moves at a double-time pace to obstacle A. Once the course is started, he continues at a safe pace through the entire course, executing each obstacle along the way, until the end is reached.
- Obstacle A, Pipe Crawl. The pipe is 6.1 meters long by 0.9 meter in diameter and is made of corrugated steel. It has a ridged surface, and Soldiers wear elbow and knee pads to

avoid injury. The Soldier assumes a crawling position approximately 1.5 meters before the entrance to the pipe. The Soldier moves as quickly as possible to complete the obstacle without causing injury to himself or damage to equipment being carried or worn. Once through the pipe crawl, the Soldier moves quickly to obstacle B.

- Obstacle B, Zigzag. The zigzag is 1.6 meters tall, 13.7 meters long, and approximately 1 meter wide. It consists of three turns (approximately 90 degrees each) within the lane. The framework is constructed of wood with mesh wire installed between the two lanes and on the outside framework of each lane. The zigzag requires the Soldier to proceed through the obstacle as quickly as possible without causing any injury to himself or damage to equipment. Once through the zigzag, the Soldier moves rapidly to obstacle C.
- Obstacle C, 2-foot Jump. The jump is a low wall, 0.6 meter high and 13 centimeters deep. The jump requires the Soldier to jump over the obstacle as quickly as possible without causing any injury. Once the jump is cleared, the Soldier moves rapidly to obstacle D.
- Obstacle D, Hill. The hill is approximately 9.8 meters long, 1.8 meters wide, and 3.2 meters tall with a 30-degree sloped incline and decline along the route of movement. The Soldier ascends and descends the mound and then moves rapidly to obstacle E.
- Obstacle E, Low Crawl. The low crawl is 12.8 meters long and 3 meters wide with an overhead cover of mesh wire approximately 0.6 meter off the ground. The Soldier assumes the low crawl position 1.5 meters before the entrance of the obstacle. He then completes the obstacle as quickly as possible using correct low crawl techniques. After completing the low crawl, the Soldier proceeds to obstacle F.
- Obstacle F, Combat Roll Station. Each lane of the combat roll station is 6 meters long and 1 meter wide. The Soldier falls to the prone position immediately after entering the station. He then executes a full combat roll to the left and then to the right, pushes off the ground using the butt stock of the weapon, executes a 3- to 5-second rush, falls back to the prone, and scans an assigned sector for possible targets. The Soldier tells the data collector when he detects a target. The Soldier then pushes off the ground using the butt stock of the weapon and moves rapidly to obstacle H. If the Soldier does not acquire the target within 20 seconds, he is instructed to move to the next obstacle.
- Obstacle G, High Crawl. Each lane of the high crawl is 12.8 meters long and 3 meters wide with an overhead cover of mesh wire approximately 0.9 meter off the ground. The Soldier moves as quickly as possible, using correct high crawl procedures, to negotiate the full length of the obstacle. Once through the high crawl, the Soldier moves rapidly to obstacle H.
- Obstacle H, Kneeling Firing Position Station. The kneeling firing position station provides a wooden support 2 meters wide, 1 meter tall, and 13 centimeters deep for the Soldier to support the weapon against during target acquisition and engagement. Upon entering the

station, the Soldier assumes a kneeling supported firing position. He then scans an assigned sector for possible targets. The Soldier tells the data collector when he detects as target and then moves to the next obstacle. If the Soldier does not acquire the target within 20 seconds, he will be instructed by the data collector to move to the next obstacle.

- Obstacle I, High Wall. The high wall is made of wood, is 1.4 meters tall, 1.8 meters wide, and 13 centimeters deep. The Soldier climbs over the obstacle as quickly as possible without causing any injury to himself or damaging equipment while maintaining control of the weapon at all times. Once the high wall is cleared, the Soldier moves rapidly to obstacle J.

- Obstacle J, Prone Firing Position Station. The prone firing position station is 2 meters long by 1 meter wide with sandbags provided to support the weapon. The Soldier enters the station and assumes a prone supported firing position. He then scans the assigned sector for targets. The Soldier tells the data collector when he detects as target. If the Soldier does not acquire the target within 20 seconds, he is instructed to move to the next station.

- Obstacle K, Urban Wall. Obstacle K is a wall that replicates several urban obstacles. The first opening replicates a breaching hole. The Soldier moves through the hole, turns around, and immediately moves through the center opening in the opposite direction. This opening replicates a window. After crawling through the window opening, the Soldier turns back around and climbs a ladder over the top of the urban wall and climbs down the ladder on the opposite side of the wall and moves toward obstacle L.

- Obstacle L, Stairs. The stairs are made of wood. Five steps lead up to a platform and five steps lead down. Once the stairs are completed and both of the Soldier's feet are on the ground, the Soldier is at the end point.

- End Point. The Soldier completes the IMT course.

This course thus provides a standardized methodology for assessing IMT woodland performance that enables control, standardization, and repeatability. Times required to complete the course were collected. Ambient light levels were high during the week of the experiment. Soldiers completed the IMT course wearing the SMaRTS and the baseline goggle once each with their unaided eye covered (to simulate no light conditions) and once with the unaided eye uncovered (to simulate high light conditions and to evaluate the ability of the Soldiers to use the images from both the aided and unaided eyes). Trials were executed according to the matrix shown in table 5. The sequence of goggles for each Soldier was counterbalanced with the restriction that each goggle appeared in each order an approximately equal number of times. Note that the first six Soldiers did not complete the trials with the baseline system and a covered eye. This condition was added on the second and successive nights of the experiment.

Table 5. IMT mobility course treatment assignment.

Roster	Iteration			
	1	**2**	**3**	**4**
1	ENVG without patch	SMaRTS without patch	SMaRTS with patch	--
2	SMaRTS without patch	SMaRTS with patch	ENVG without patch	--
3	SMaRTS with patch	ENVG without patch	SMaRTS without patch	--
4	ENVG without patch	SMaRTS without patch	SMaRTS with patch	--
5	SMaRTS without patch	SMaRTS with patch	ENVG without patch	--
6	SMaRTS with patch	ENVG without patch	SMaRTS without patch	--
7	ENVG without patch	SMaRTS without patch	ENVG with patch	SMaRTS with patch
8	SMaRTS without patch	ENVG with patch	SMaRTS with patch	ENVG without patch
9	ENVG with patch	SMaRTS with patch	ENVG without patch	SMaRTS without patch
10	SMaRTS with patch	ENVG without patch	SMaRTS without patch	ENVG with patch
11	SMaRTS with patch	ENVG with patch	SMaRTS without patch	ENVG without patch
12	ENVG with patch	SMaRTS without patch	ENVG without patch	SMaRTS with patch
13	ENVG with patch	ENVG without patch	SMaRTS with patch	SMaRTS without patch
14	ENVG without patch	SMaRTS with patch	ENVG with patch	SMaRTS without patch
15	ENVG without patch	SMaRTS with patch	ENVG with patch	SMaRTS without patch
16	SMaRTS without patch	ENVG without patch	ENVG with patch	SMaRTS with patch
17	SMaRTS with patch	ENVG with patch	SMaRTS without patch	ENVG without patch
18	SMaRTS with patch	ENVG without patch	ENVG with patch	SMaRTS without patch
19	SMaRTS with patch	ENVG with patch	ENVG without patch	SMaRTS without patch
20	ENVG with patch	SMaRTS with patch	SMaRTS without patch	ENVG without patch
21	SMaRTS without patch	SMaRTS with patch	ENVG with patch	ENVG without patch
22	ENVG without patch	ENVG with patch	SMaRTS without patch	SMaRTS with patch
23	SMaRTS with patch	ENVG without patch	SMaRTS without patch	ENVG with patch
24	SMaRTS without patch	ENVG without patch	SMaRTS with patch	ENVG with patch
25	ENVG with patch	SMaRTS with patch	ENVG without patch	SMaRTS without patch
26	ENVG without patch	SMaRTS without patch	SMaRTS with patch	ENVG with patch
27	SMaRTS without patch	ENVG with patch	ENVG without patch	SMaRTS with patch
28	ENVG with patch	SMaRTS without patch	SMaRTS with patch	ENVG without patch
29	ENVG without patch	SMaRTS without patch	SMaRTS with patch	ENVG with patch
30	SMaRTS without patch	SMaRTS with patch	ENVG without patch	ENVG with patch _

At the completion of the exercises with each of the baseline and prototype goggles, a subjective questionnaire was administered. In addition, data collector observations were recorded after each trial. If specific obstacles or positions were more difficult or time consuming to execute, the reasons were determined and documented so that corrective actions could be taken in equipment design or procedures.

2.4.4 Cross-Country Woodland Patrol Course

Soldiers initially walked through the course, and each obstacle and position was explained before they ran the first record trial. In addition, all Soldiers completed one familiarization trial wearing their uniforms, standard fighting loads, and carrying their assigned weapons.

Times required to complete the course were collected. Ambient light levels were high during the week of the experiment. Soldiers completed the cross-country course wearing the SMaRTS and the baseline goggle once each with their unaided eye covered (to simulate no light conditions) and once with the unaided eye uncovered (to simulate high light conditions and to evaluate the ability of the Soldiers to use the images from both the aided and unaided eyes). Trials were executed according to the matrix shown in table 6. The sequence of goggles for each Soldier was counterbalanced with the restriction that each goggle appeared in each order an approximately equal number of times. Note that the first six Soldiers did not complete the trials with the baseline system and a covered eye. This condition was added on the second and successive nights of the experiment.

Table 6. Cross-country woodland patrol course treatment assignment.

	Iteration			
Roster	**1**	**2**	**3**	**4**
1	SMaRTS with patch	ENVG without patch	SMaRTS without patch	--
2	ENVG without patch	SMaRTS without patch	SMaRTS with patch	--
3	SMaRTS without patch	SMaRTS with patch	ENVG without patch	--
4	SMaRTS with patch	ENVG without patch	SMaRTS without patch	--
5	ENVG without patch	SMaRTS without patch	SMaRTS with patch	--
6	SMaRTS without patch	SMaRTS with patch	ENVG without patch	--
7	ENVG without patch	ENVG with patch	SMaRTS without patch	SMaRTS with patch
8	SMaRTS with patch	ENVG with patch	ENVG without patch	SMaRTS without patch
9	SMaRTS without patch	SMaRTS with patch	ENVG without patch	ENVG with patch
10	ENVG without patch	SMaRTS without patch	SMaRTS with patch	ENVG with patch
11	SMaRTS without patch	ENVG with patch	ENVG without patch	SMaRTS with patch
12	SMaRTS with patch	ENVG without patch	ENVG with patch	SMaRTS without patch
13	ENVG without patch	SMaRTS without patch	ENVG with patch	SMaRTS with patch
14	SMaRTS without patch	ENVG with patch	SMaRTS with patch	ENVG without patch
15	ENVG with patch	SMaRTS with patch	ENVG without patch	SMaRTS without patch
16	SMaRTS with patch	ENVG without patch	SMaRTS without patch	ENVG with patch
16	SMaRTS with patch	ENVG with patch	SMaRTS without patch	ENVG without patch
17	ENVG with patch	SMaRTS without patch	ENVG without patch	SMaRTS with patch
18	SMaRTS without patch	SMaRTS with patch	ENVG with patch	ENVG without patch
20	ENVG with patch	ENVG without patch	SMaRTS with patch	SMaRTS without patch
21	SMaRTS without patch	ENVG without patch	ENVG with patch	SMaRTS with patch
22	ENVG with patch	SMaRTS with patch	SMaRTS without patch	ENVG without patch
23	SMaRTS without patch	SMaRTS with patch	ENVG with patch	ENVG without patch
24	ENVG without patch	ENVG with patch	SMaRTS without patch	SMaRTS with patch
25	SMaRTS with patch	ENVG without patch	SMaRTS without patch	ENVG with patch
26	ENVG without patch	SMaRTS without patch	SMaRTS with patch	ENVG with patch
27	ENVG with patch	SMaRTS without patch	SMaRTS with patch	ENVG without patch
28	SMaRTS with patch	ENVG without patch	ENVG with patch	SMaRTS without patch
29	ENVG with patch	SMaRTS with patch	ENVG without patch	SMaRTS without patch
30	ENVG without patch	SMaRTS without patch	SMaRTS with patch	ENVG with patch

After each iteration, the Soldiers completed questionnaires regarding their ability to negotiate the course using each system. In addition, data collector observations were recorded after each trial.

2.4.5 Target Laser Exercise

Soldiers were given a simulated M4 carbine with an AN/PEQ-4 mounted and boresighted to complete this exercise. They were directed by the data collector to "lase" targets at ranges from 25 meters to 100 meters according to table 7. The Soldiers "lased" each target three times at each range wearing the goggles as specified in table 8. Only the I^2 setting was used since the targets were not heated.

Table 7. Order of target presentation, target laser exercise.

Roster	Iteration	Presentation Order (m)		
		1	2	3
1,4,7,10,13,16,19,22,25,28	1	100	50	25
	2	50	25	100
	3	25	100	50
2,5,8,11,14,17,20,23,26,29	1	25	50	100
	2	100	25	50
	3	50	100	25
3,6,9,12,15,18,21,24,27,30	1	100	50	25
	2	25	50	100
	3	50	25	100

The data collector used a laser aiming light to designate the target for the Soldier to fire upon. Upon completion of the exercise with each goggle, the Soldier completed a questionnaire that solicited his opinions concerning the ease of completing this exercise.

Table 8. Target "lasing" treatment assignment.

Roster	Iteration		
	1	2	3
1	ENVG	BB	SMaRTS
2	SMaRTS	BB	ENVG
3	BB	SMaRTS	ENVG
4	ENVG	SMaRTS	BB
5	BB	ENVG	SMaRTS
6	SMaRTS	ENVG	BB
7	BB	SMaRTS	ENVG
8	ENVG	SMaRTS	BB
9	BB	ENVG	SMaRTS
10	SMaRTS	BB	ENVG
11	SMaRTS	ENVG	BB
12	ENVG	BB	SMaRTS
13	BB	ENVG	SMaRTS
14	SMaRTS	ENVG	BB
15	ENVG	SMaRTS	BB
16	BB	SMaRTS	ENVG
17	ENVG	BB	SMaRTS
18	SMaRTS	BB	ENVG
19	SMaRTS	BB	ENVG
20	BB	ENVG	SMaRTS
21	ENVG	BB	SMaRTS
22	SMaRTS	ENVG	BB
23	BB	SMaRTS	ENVG
24	ENVG	SMaRTS	BB
25	SMaRTS	ENVG	BB
26	ENVG	BB	SMaRTS
27	SMaRTS	BB	ENVG
28	BB	ENVG	SMaRTS
29	ENVG	SMaRTS	BB
30	BB	SMaRTS	ENVG

2.4.6 Mount/Dismount Aiming Light

Each Soldier mounted and dismounted an aiming light on an M4 carbine three times while using the I^2 setting of each candidate system and the baseline system. When the Soldier arrived at the station, he was assigned a system and given an AN/PEQ-4 and a simulated M4 carbine. His time to mount and then dismount the weapon sight was recorded. He accomplished this task three times with each of the two candidate and the baseline systems, as shown in table 9. Upon completion of each trial, the Soldier completed a questionnaire that solicited his response to ease of completing this exercise.

Table 9. Aiming light mount and dismount matrix.

Roster	Iteration		
	1	2	3
1	BB	ENVG	SMaRTS
2	SMaRTS	ENVG	BB
3	ENVG	SMaRTS	BB
4	BB	SMaRTS	ENVG
5	ENVG	BB	SMaRTS
6	SMaRTS	BB	ENVG
7	ENVG	SMaRTS	BB
8	BB	SMaRTS	ENVG
9	SMaRTS	ENVG	BB
10	ENVG	BB	SMaRTS
11	SMaRTS	BB	ENVG
12	BB	ENVG	SMaRTS
13	BB	SMaRTS	ENVG
14	ENVG	SMaRTS	BB
15	BB	ENVG	SMaRTS
16	SMaRTS	BB	ENVG
17	SMaRTS	ENVG	BB
18	ENVG	BB	SMaRTS
19	ENVG	BB	SMaRTS
20	SMaRTS	BB	ENVG
21	BB	SMaRTS	ENVG
22	ENVG	SMaRTS	BB
23	BB	ENVG	SMaRTS
24	SMaRTS	ENVG	BB
25	SMaRTS	ENVG	BB
26	ENVG	BB	SMaRTS
27	SMaRTS	BB	ENVG
28	BB	ENVG	SMaRTS
29	ENVG	SMaRTS	BB
30	BB	SMaRTS	ENVG

2.5 Experimental Design

2.5.1 Independent Variable

The independent variable is the type of NVD (two prototypes and one baseline).

2.5.2 Dependent Variables

2.5.2.1 Grid Location Exercise

- Magnitude and direction of errors in touching the center target using the baseline and candidate systems,

- Data collectors' observations of Soldiers conducting the exercise with the baseline and candidate systems,
- Soldiers' questionnaire responses regarding any disorientation or difficulties experienced with the baseline and candidate systems.

2.5.2.2 IMT Woodland

- Times to complete the course with the baseline and candidate systems,
- Data collectors' observations of Soldiers negotiating the course with the baseline and candidate systems,
- Soldiers' questionnaire responses regarding IMT with each the baseline and candidate systems.

2.5.2.3 Woodland Patrol

- The time to complete the course using the baseline and candidate systems,
- Data collectors' observations of Soldiers completing the trials with the baseline and candidate systems,
- Soldiers' questionnaire responses regarding traversing woodland terrain with the baseline and candidate systems.

2.5.2.4 Target "Lasing" Exercise

- Percent of targets "lased,"
- The target range and location of the Soldier's laser aiming device on the target using the baseline and candidate systems,
- Data collectors' observations of Soldiers completing the trials with the baseline and candidate systems,
- Soldiers' questionnaire responses regarding the "lasing" of targets with the baseline and candidate systems.

2.5.2.5 Mount/Dismount Weapon Sight

- The time to complete the mounting and dismounting of the AN/PEQ-4 using the baseline and candidate systems,
- Data collectors' observations of Soldiers completing the trials with the baseline and candidate systems,
- Soldiers' responses regarding mounting and dismounting the sight on a weapon.

3. Results

3.1 Training and Demographics

3.1.1 Training

Eighteen of the Soldiers had previous experience with night vision devices and 12 had none. Even those Soldiers with no previous experience rated all the training highly and stated that it adequately prepared them to use the prototypes and baseline devices in the field exercises.

Detailed results from the training questionnaire are contained in appendix D.

3.1.2 Demographics

The weights of the Soldiers ranged from the 3rd to the 90th percentile. Their height ranged from the 14th to the 99th percentile. Ten Soldiers wore corrective lenses. Five of the 30 Soldiers were left eye dominant.

Detailed results from the demographics questionnaire are contained in appendix D.

3.2 Grid Location Exercise

Tables 10 through 12 show the deviations from zero in inches in each operational mode for the three systems. The final column in each table contains the Cohen's *d* statistic, a measure of effect size. The *d* statistic is the mean difference from zero divided by the SD (standard deviation). By convention, $d = 0.2$ is considered a small effect, $d = 0.5$ a medium effect, and $d = 0.8$ a substantial effect size. In the I^2 mode, Soldiers using the SMaRTS and the brassboard systems tended to hit low on the grid. Because of difficulty changing the brassboard system mode from I^2 to thermal and mix mode, it was decided to use only the I^2 mode for that system during this exercise, since the system had a common aperture. The thermal system in the SMaRTS being used for this exercise broke after the first day of the experiment so the sample sizes for the SMaRTS thermal and mixed modes are small.

Table 10. Deviations from zero, grid location exercise, I^2 mode.

System	Axis	Mean	SD	t	df	p	*d*
ENVG	X	-0.09	0.49	0.99	28	0.329	0.18
	Y	0	0.65	0		0.999	0
SMaRTS	X	-0.07	1.39	0.29	29	0.778	0.05
	Y	-1.65	1.61	5.61		<.001*	1.02
Brassboard (BB)	X	-0.5	1.23	1.91	21	0.07	0.41
	Y	-1.66	1.24	6.31		<.001*	1.34

**p < .05 , 2-tailed*

Table 11. Deviations from zero, grid location exercise, thermal mode.

System	Axis	Mean	SD	t	df	p	*d*
ENVG	X	0.00	0.43	0	28	0.999	0
	Y	-0.17	0.58	1.50		0.144	0.28
SMaRTS	X	0.24	1.13	0.56	5	0.597	0.21
	Y	-0.39	0.65	1.47		0.200	0.60

Table 12. Deviations from zero, grid location exercise, I^2 – thermal mix mode.

System	Axis	Mean	SD	t	df	p	*d*
ENVG	X	-0.06	0.36	0.87	28	0.392	0.16
	Y	-0.19	0.73	1.38		0.178	0.26
SMaRTS	X	0.72	1.42	1.24	6	0.269	0.51
	Y	-0.50	0.91	1.34		0.239	0.55
BB	X	-3.33	0.58	x	3	x	x
	Y	0.00	2.00	x		x	x

Soldiers stated that they had much more difficulty finding and touching the center grid when they were wearing the SMaRTS and the brassboard systems than when wearing the baseline goggles. When wearing the SMaRTS and the brassboard systems, they reported having to compensate for the offset sensors by adjusting their reach from where the center grid appeared to be when they looked through the system to where it actually was when they used their knowledge of the offset position. They reported that when they turned, it took a while for the image in the brassboard and SMaRTS (and to some extent the baseline when used in the thermal and mix mode) to catch up with where they were looking (thermal lag). They also had difficulty getting a close focus with the brassboard. Soldiers did note that when the ENVG baseline was in the mix mode, the thermal and I^2 images were offset, but this did not seem to cause them problems.

Detailed questionnaire results are in appendix D.

3.3 Woodland IMT Course Trials

Table 13 shows the mean times to complete the IMT course with the two systems, with and without an eye patch on the unaided eye. Without the eye patch, the Soldiers were significantly faster using the ENVG than they were using the SMaRTS system ($t(df=29) = 2.24$, $p = 0.033$, $\eta^2_p = 0.148$). The mean course completion time for the ENVG was also significantly faster than SMaRTS course completion time in the eye patch condition ($t(df=23) = 9.37$, $p < 0.001$, $\eta^2_p = 0.792$).

Table 13. Time (min:sec) to complete woodland IMT course.

	Without Patch		With Patch	
System	Mean	SD	Mean	SD
ENVG	1:49	0:15	2:04	0:23
SMaRTS	2:01	0:28	2:46	0:27

Soldiers commented that the ENVG and unaided eye provided better depth perception than the ENVG worn with an eye patch over the unaided eye. However, they rated both baseline ENVG conditions highly for performance of the IMT obstacle course tasks. They rated ease of obstacle course tasks easier when the SMaRTS was worn without the eye patch. Several Soldiers stated that this was because they relied heavily on their unaided eye for course negotiation when it was uncovered. One Soldier stated that when wearing the SMaRTS and the patch over the unaided eye, everything was in a different spot than where it looked to be. Another Soldier fell into the foxhole and tripped on top of the platform when he wore the SMaRTS with the eye patch on the unaided eye. Overall, performance and Soldier acceptance was much lower for this condition, which would be similar to SMaRTS performance in very dark conditions.

Soldiers reported problems with the SMaRTS image in both SMaRTS conditions as very bad during movement. The image focus was reported to change and the weight of the system made it bounce up and down when they were running. Others reported that the offset sensor made it difficult to determine the true location of obstacles. The lag in the system was especially apparent when the Soldiers were running.

One Soldier stated that he preferred the color contrast (red and green) provided by the baseline ENVG than the black and white provided by the SMaRTS because it aided him in scene interpretation.

Verbatim transcripts of Soldier questionnaire responses are in appendix D.

3.4 Woodland Patrol

Times to complete the woodland patrol course are shown in table 14. Without the eye patch over the unaided eye, there was no significant difference between the two systems in course completion times ($t(df=29) = 1.69$, $p = 0.102$, $\eta^2_p = 0.090$). In the eye patch conditions, Soldiers completed the course significantly faster with the ENVG than with the SMaRTS system ($t(df=23) = 7.05$, $p < 0.001$, $\eta^2_p = 0.683$).

Table 14. Time (min:sec) to complete woodland patrol course.

System	Without Patch		With Patch	
	Mean	SD	Mean	SD
ENVG	2:45	0:42	2:43	0:49
SMaRTS	2:56	0:44	4:15	1:15

Soldiers commented that when they wore the ENVG with their unaided eye uncovered and covered, it was very easy for them to negotiate the patrol course. The only problem they seemed to have was negotiation of downhill slopes.

When Soldiers wore the SMaRTS with their unaided eye uncovered, they stated that they often used their unaided eye for depth perception tasks and to walk. There were several complaints about depth perception when they were not able to use their unaided eye. Soldiers stated that the

system was not fast enough to keep pace with their head movement. Slow focus, brightness changes, and camera lag were blamed for the system's inability to keep pace with them when they tried to move quickly. In several trials, the screen "whited out" when they jarred the system while moving. Soldiers wearing the SMaRTS with the unaided eye covered by an eye patch rated the course completion as difficult. They stated that their depth perception was very poor and that they had a very hard time seeing the vegetation through the SMaRTS. Table 15 shows the number of Soldiers who stated that they had difficulty negotiating the woodland patrol course.

Table 15. Number of soldiers having difficulty negotiating the woodland patrol course.

	Number of Responses			
	ENVG (no eye cover)	**SMaRTS (no eye cover)**	**SMaRTS (eye cover)**	**ENVG (eye cover)**
Problems	1	11	24	1
No problem	27	18	6	22
NR	2	1	0	7

Soldiers rated the field of view, the perception of depth, the picture brightness and the picture clarity of the SMaRTS much lower than they did the ENVG.

3.5 Target Laser Exercise

Table 16 shows the proportion of laser "hits" at each range with the three systems. The difference in total hit rates for the three systems was statistically significant (χ^2 (df=2) = 71.0. $p < 0.001$). Ensuing comparisons show that the ENVG hit rate was significantly higher than the SMaRTS hit rate (χ^2 (df=1) = 11.9, $p < 0.001$), and the SMaRTS hit rate was significantly higher than the brassboard hit rate (χ^2 (df=1) = 24.2, $p < 0.001$).

Table 16. Target laser hit rate.

System	**25 m (percent)**	**50 m (percent)**	**100 m (percent)**	**Total (percent)**
ENVG	100	100	77	92
SMaRTS	90	73	50	71
BB	57	27	17	33

Tables 17 through 19 show the mean deviations in 2-inch increments from center in target "lasing" at three ranges with the three systems. Soldiers had a tendency to aim low with all three systems.

Table 17. Deviations from zero, target laser, 25 meters.

System	**Axis**	**Mean**	**SD**	**t**	**df**	**p**	***d***
ENVG	X	-0.67	0.80	4.55	29	< .001*	0.84
	Y	-2.37	1.75	7.4		< .001*	1.35
SMaRTS	X	-0.32	0.82	2.08	27	0.047*	0.39
	Y	-1.54	1.55	5.24		< .001*	0.99
BB	X	0.00	0.87	0	16	1	0.00
	Y	-2.00	1.50	5.5		< .001*	1.33

**p < .05 , 2-tailed*

Table 18. Deviations from zero, target laser, 50 meters.

System	Axis	Mean	SD	t	df	p	*d*
ENVG	X	-0.27	1.34	1.09	29	0.284	0.20
	Y	-2.59	2.54	5.48		<.001*	1.02
SMaRTS	X	-0.3	0.97	1.50	22	0.148	0.31
	Y	-2.35	2.10	5.36		<.001*	1.12
BB	X	1.13	1.81	1.76	7	0.122	0.62
	Y	-2.89	2.57	3.37		0.01	1.12

**p < .05 , 2-tailed*

Table 19. Deviations from zero, target laser, 100 meters.

System	Axis	Mean	SD	t	df	p	*d*
ENVG	X	-0.30	0.56	2.61	22	0.016*	0.54
	Y	-2.61	4.00	3.13		0.005*	0.65
SMaRTS	X	-0.73	1.33	2.13	14	0.052	0.55
	Y	-2.79	3.07	3.40		0.005*	0.91
BB	X	-0.60	1.52	0.88	4	0.426	0.39
	Y	-2.60	2.70	2.15		0.098	0.96

**p < .05 , 2-tailed*

Although the objective data do not indicate consistent differences among the three systems in terms of laser accuracy, Soldiers stated that they could see the distant targets (targets at ranges greater than 25 meters) much better with the ENVG than they could with the SMaRTS and brassboard systems. They complained that the SMaRTS and brassboard systems did not provide enough information or detail to see the 50- and 100-meter targets. Also, the fog that was present during some of the laser firings did not seem to affect the ENVG performance as adversely as it did the other systems.

3.6 Mount/Dismount Aiming Light

Table 20 shows the mean times to mount and dismount the aiming light with the three night vision systems.

Table 20. Times (seconds) to mount and dismount aiming light.

	Mount		Dismount	
System	Mean	SD	Mean	SD
ENVG	45.7	38.8	15.5	7.3
SMaRTS	57.2	30.3	15.3	5.4
brassboard	76.3	45.3	20.3	11.3

A repeated measures analysis of variance (ANOVA) indicates that there was a significant difference among the three systems in terms of mean time to mount the aiming light ($F(2,56) = 6.64$, $p = 0.003$, $\eta^2_p = 0.192$). Ensuing comparisons using Holm's Bonferroni correction for family-wise error, summarized in table 21, show that Soldiers were able to mount

the aiming light significantly faster while wearing the ENVGs than while wearing the brassboard.

Table 21. Ensuing comparisons, time to mount aiming light.

Comparison	t	df	obtained p	required p
ENVG vs. SMaRTS	1.58	28	0.125	0.05
ENVG vs. BB	3.53	28	0.001*	0.017
SMaRTS vs. BB	2.04	28	0.051	0.025

**p < .05, 2-tailed*

There was also a significant difference among means for the time to dismount the aiming light ($F(2,56) = 4.57$, $p = 0.015$, $\eta^2_p = 0.140$). Ensuing comparisons (table 22) show that there were no significant pairwise differences. However, there was a trend for dismounting the aiming light to be faster with both the ENVG and the SMaRTS relative to the brassboard system.

Table 22. Ensuing comparisons, time to dismount aiming light.

Comparison	t	df	obtained p	required p
ENVG vs. SMaRTS	0.22	28	0.826	0.05
ENVG vs. BB	2.07	28	0.048	0.025
SMaRTS vs. BB	2.42	28	0.022	0.0167

Most Soldiers stated that they had difficulty grasping objects that were close to them (the aiming light components) when they wore the SMaRTS and the brassboard systems. Depth perception difficulties and inability to focus closely were the most cited reasons for this difficulty. Only five of the 30 Soldiers stated that they had difficulty grasping close objects when wearing the baseline goggle.

3.7 Human Factors Engineering Evaluation

Throughout all the exercises, the Soldiers reported problems that they experienced while wearing the goggles. Table 23 indicates the percent of times problems were reported by the Soldiers during all exercises. The actual number of times these problems are reported and the exercises in which they were reported are given in appendix D in each of the questionnaires. Percentages were used rather than numbers because the brassboard and the baseline and SMaRTS with eye cover were not used as many times as the baseline and SMaRTS without eye cover.

Table 23. Percent of the time that problems were experienced with each goggle during all exercises.

Problem	No Eye Cover			Eye Cover	
	ENVG (percent)	SMaRTS (percent)	brassboard (percent)	ENVG (percent)	SMaRTS (percent)
Eyestrain	3	13	18	2	20
Tunnel vision	6	7	5	10	17
Headaches	0	2	7	2	2
Motion sickness	0	1	0	0	2
Nausea	0	2	0	0	0
Disorientation	6	13	12	8	30
Dizziness	0	1	0	2	3
Lens fogging	4	2	0	3	3
Screen white-out	0	5	3	2	10

Soldiers reported more incidences of eyestrain and much more disorientation with the digital devices than with the baseline. These problems should be investigated further so that specific causes can be identified.

3.7.1 Baseline ENVG Goggle

Soldiers were generally impressed with the baseline device and thought that it should be fielded immediately. They liked the two colors used to differentiate between the thermal and I^2 pictures. Their average rating of the depth perception of the baseline was "very good," the SMaRTS was "neutral," and for the brassboard was "bad". A few Soldiers had problems with the depth perception of the baseline, but most did not. The good depth perception rating for the ENVG when the unaided eye was uncovered might be attributable to the stereopsis (the result of the two retinae viewing slightly different images of the same object because of the different location of the right and left eyes) available with the baseline because of the direct view through the I^2 sensor. Some Soldiers are capable of achieving some degree of depth perception with a monocular device that allows adjustment of gain by turning down the gain (so that retinal rivalry does not occur) and collimating the view of the aided and unaided eyes (McLean, 1998).

The primary complaint about the baseline device was that the thermal image was not perfectly aligned with the I^2 image when Soldiers viewed objects closely.

3.7.2 SMaRTS Goggle

Soldiers reported that they had problems with several features of the SMaRTS goggle. First, they had problems with the vision provided by the device. Probably the most significant problems were the sensor offset affecting their depth perception when they wore the device and the long delay in its scene presentation because of lag times, possible slow update rates, and slow changes in focus and brightness. (The term "lag" is used here to mean the time between when the head moves and when the presented image changes to reflect this movement. The frequency at which new display image frames are presented [display refresh] is called the update rate.) The

lag in the picture was apparent during movement and turning. The black-and-white image did not allow them to determine whether what they were seeing was a "hot" target (human) or whether it was a cold target (rock). This made target recognition more difficult.

The offset of the sensors on the SMaRTS goggle presents an image that causes a large number of Soldiers to reach for objects below their true location. This created problems when the Soldiers' unaided eye was covered because they often did not step where they thought they were stepping. When the unaided eye was uncovered, many Soldiers relied heavily on the vision from that eye to negotiate the IMT and patrol course. Soldiers were unable to fuse the images from the aided and unaided eyes because of the disparity between the images. The two unaligned optical channels (aided and unaided) create the disparity between the imagery presented to the two eyes. These disparities are alignment errors and optical image differences. Alignment errors are because of the lack of parallelism of the two optical axes and the optical image differences are attributable to contrast, distortion, and luminance. The magnitude of disparity appears to be more than can be tolerated before performance noticeably degrades, and eyestrain occurs from attempts at accommodation.

3.7.3 brassboard Goggle

Evaluation of the brassboard device was limited because of its fragility and because the device had to be hooked to a computer to change the mix of I^2 to thermal. Thus, the only time Soldiers walked while wearing this device was from the building to the firing line. Even this simple movement was extremely difficult for them while they looked through the device. In fact, many of them had to be led by the hand to the firing line.

The Soldiers had to zero this device before they were able to use it to complete tasks because the display rotated separately from the sensors. Each Soldier had to look at an object such as another Soldier to align the display with the sensor. Even after the device was "zeroed[1]," it was not clear that all Soldiers were able to obtain the proper alignment. Some Soldiers observed that the sight picture from the aided eye was offset from the unaided eye when they tried to keep both eyes open. As with the SMaRTS goggle, the two unaligned optical channels (aided and unaided) also created disparities between the imagery presented to the two eyes. These disparities are alignment errors and optical image differences. Alignment errors are because of the lack of parallelism of the two optical axes and the optical image differences are attributable to contrast, distortion, size (magnification), and luminance. The magnitude of disparity appears to be more than can be tolerated before performance noticeably degrades, and eyestrain from attempts at accommodation occurs.

[1]Zeroed means that the angle of elevation of the weapon is adjusted so that in the absence of all other errors, the round will impact at a specific predetermined location.

4. Conclusion

An important limitation to this study is that Soldiers only used the prototype digital goggles for a single night. It is possible that with more extended use, the Soldiers may become accommodated to the optical distortions produced by the offset sensors.

5. Recommendations

Placement of the components of a helmet-mounted digitally fused system should minimize the off-center moment and the moment of inertia of the helmet sensor and display system on the operator's head. Stability of the goggle on the helmet, as well as helmet stability, is extremely important.

Complex menu systems for fusion adjustment consume time and decrease Soldier acceptance. However, it is important to allow different fusion mixes for different tasks. The mixing and adjusting of the I^2 and thermal images are critical to the effective operation of a fused goggle.

Adjustment of the placement of the display over the eye must be flexible to allow for individual anthropometric differences, the use of protective eyewear, and differences in eye dominance and to avoid potential injury to the Soldier's eye. However, the display must be properly aligned (boresighted) with the sensors.

Resolution of digital goggles needs to be high so that detection of human targets at ranges longer than 25 meters can be accomplished. Problems with system lag, update rates, automatic focus and brightness adjustment should be negated. Visual characteristics such as those that cause eyestrain and disorientation problems should also be addressed. Variable gain and flexibility of the adjustment of the placement of the display over the eye are important so that the non-display viewing eye can remain dark adapted to the ambient level of illumination and so that peripheral vision detections can be made with the display viewing eye. Soldiers should learn to fuse the image of the aided and unaided eye. In order to do this, the Soldiers should learn to adjust the manual gain, eyepiece, and objective lens focus and learn to adjust the helmet bracket and align the display to the viewing eye. Color in a fused system aids target recognition by helping the Soldier differentiate between hot (possibly human) targets and cold targets such as rocks and stumps.

It is clear that further research is needed before digital fusion goggles are fielded. Future research should include laboratory tests to address the alignment of the optics. It is extremely important to fully understand the impact of sensor placement on dismounted Soldier

performance, so a study should be conducted to quantify the effect of different placement locations on performance using some type of system that controls for all variables except sensor placement. Future research should also address the question of accommodation to optical distortions over time.

6. References

Bonnett, C. C.; Redden, E. S.; Carstens, C. B. *Enhanced Night Vision Goggles Limited User Evaluation*; Technical Report; U.S. Army Research Laboratory: Aberdeen Proving Ground, MD, to be published.

CuQlock-Knopp, V. G.; Myles, K. P.; Malkin, F. J.; Bender, E.; Merritt, J. O. *The Effects of Viewpoint Offsets of Night Vision Goggles on Human Performance in a Simulated Grenade-Throwing Task*; ARL-TR-2407; U.S. Army Research Laboratory: Aberdeen Proving Ground, MD, 2001.

McLean W. E. *Exploratory Optical and Visual Evaluation of the AN/PVS-14 Monocular Night Vision Device*; USAARL TM-98-38; U.S. Army Aeromedical Research Laboratory: Fort Rucker, AL, 1998.

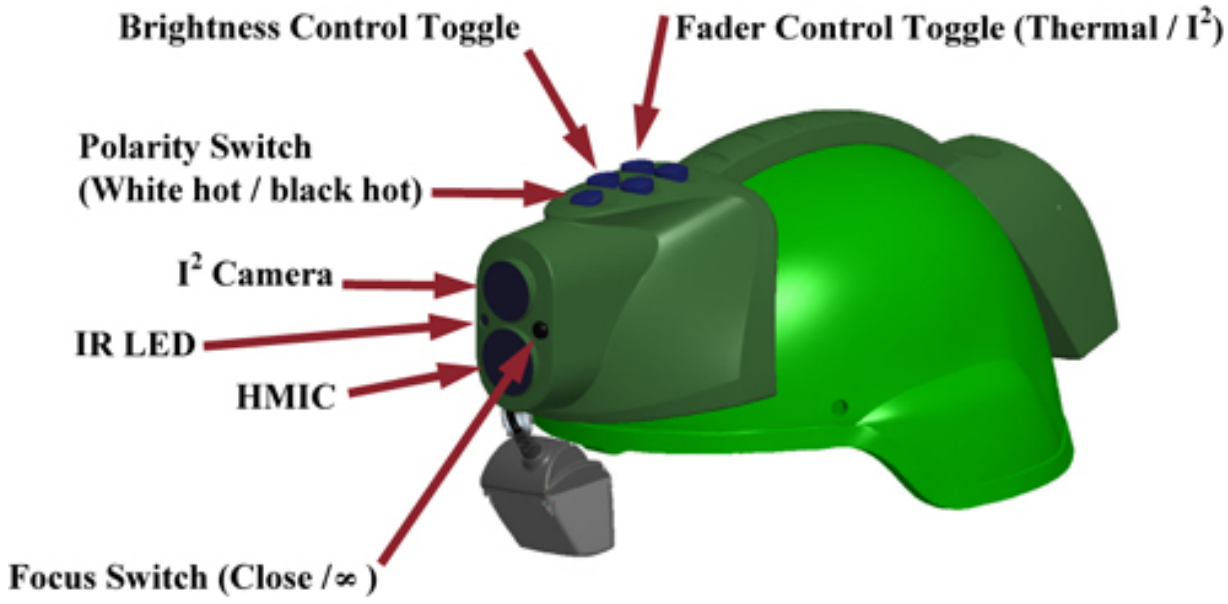
Appendix A. SMaRTS Helmet-Mounted Sensor System

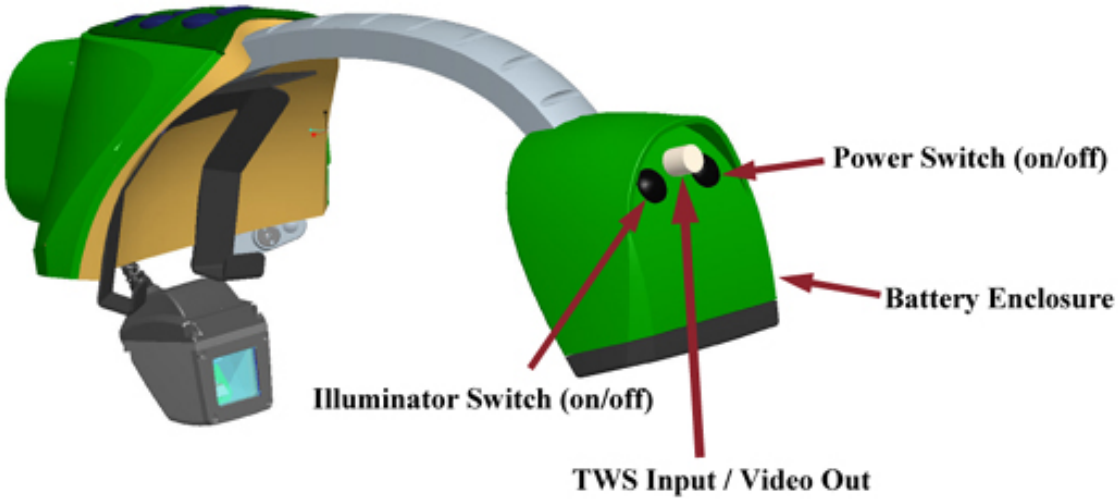
The SMaRTS system is designed as a helmet-mounted fused, multi-spectral sensor system for infantry Soldiers. The system contains VISNIR (I^2 waveband) and LWIR (thermal, also called the helmet-mounted infrared camera, or HMIC) sensors mounted in a dual-aperture, vertical orientation. The imagery is viewed on a high-resolution, non-see-through, monochrome HMD which can be adjusted to be viewed by the left or right eye. SMaRTS is intended to mount on the Soldier's personal MICH.

Weight breakdown for SMaRTS is as follows:

Weight	7.6 lb (including medium MICH)
Weight breakdown	MICH: 3.35 lb
	Sensor module (including battery): 4.35 lb
	Battery: 0.65 lb

Control features are shown below:




Power Switch (on/off)
Battery Enclosure
Illuminator Switch (on/off)
TWS Input / Video Out

Appendix B. FFW Headgear IPT brassboard System

Introduction

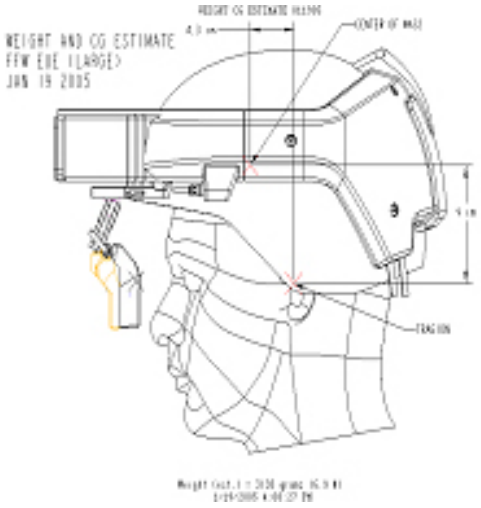
The FFW headgear brassboard system was assembled in early 2005 for the purpose of evaluating the performance of the single aperture, fused, multi-wavelength sensor concept. Because of the configuration (helmet + backpack electronics), it is intended as a performance evaluation platform in controlled environments *and should not be considered for use in the field*. The following photographs show the configuration of the brassboard system.

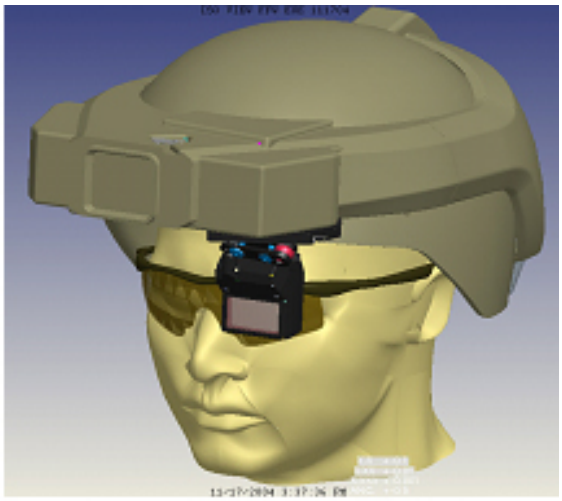
Helmet Subsystem Description

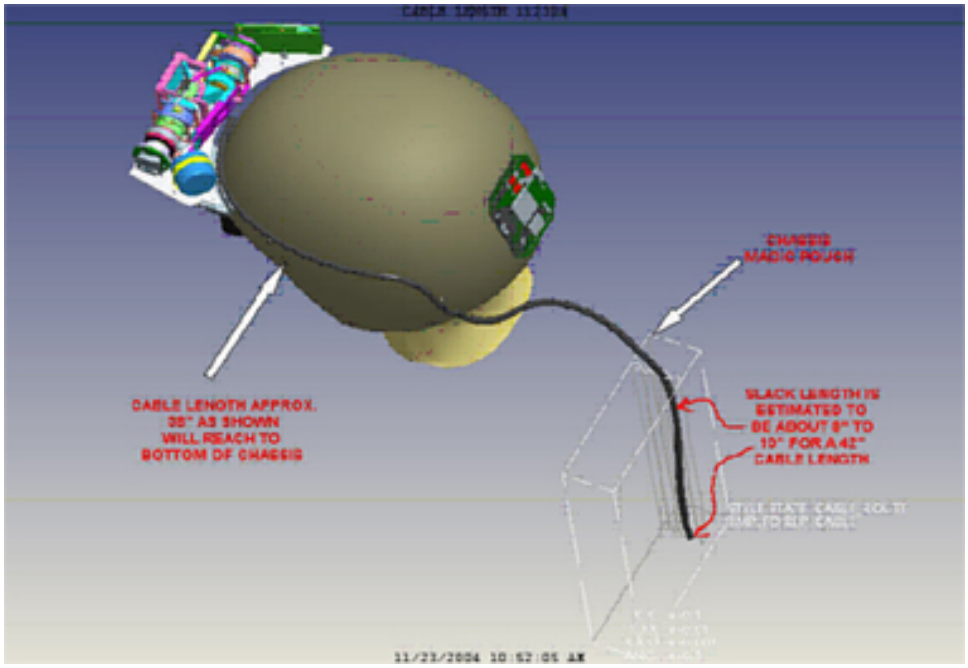
The helmet subsystem includes sensors (LWIR and VISNIR or I^2) and optics for combining and focusing images from the sensors. A sensor-optics assembly is attached to the front of the helmet, as illustrated in the following figure. An LCD display module is attached below this assembly, which can be positioned over the user's eye. The electronics for driving the LCD display module (HMD driver CCA) can be seen on the back side of the helmet. The remainder of the electronics are located in a chassis stowed in the user's backpack.

There is cabling attached to the helmet running down to a chassis stowed in a custom backpack. It accommodates the chassis and a battery pack with adequate ventilation for cooling purposes. This cabling is a bundle of five, 1/4-inch, control and video cables.

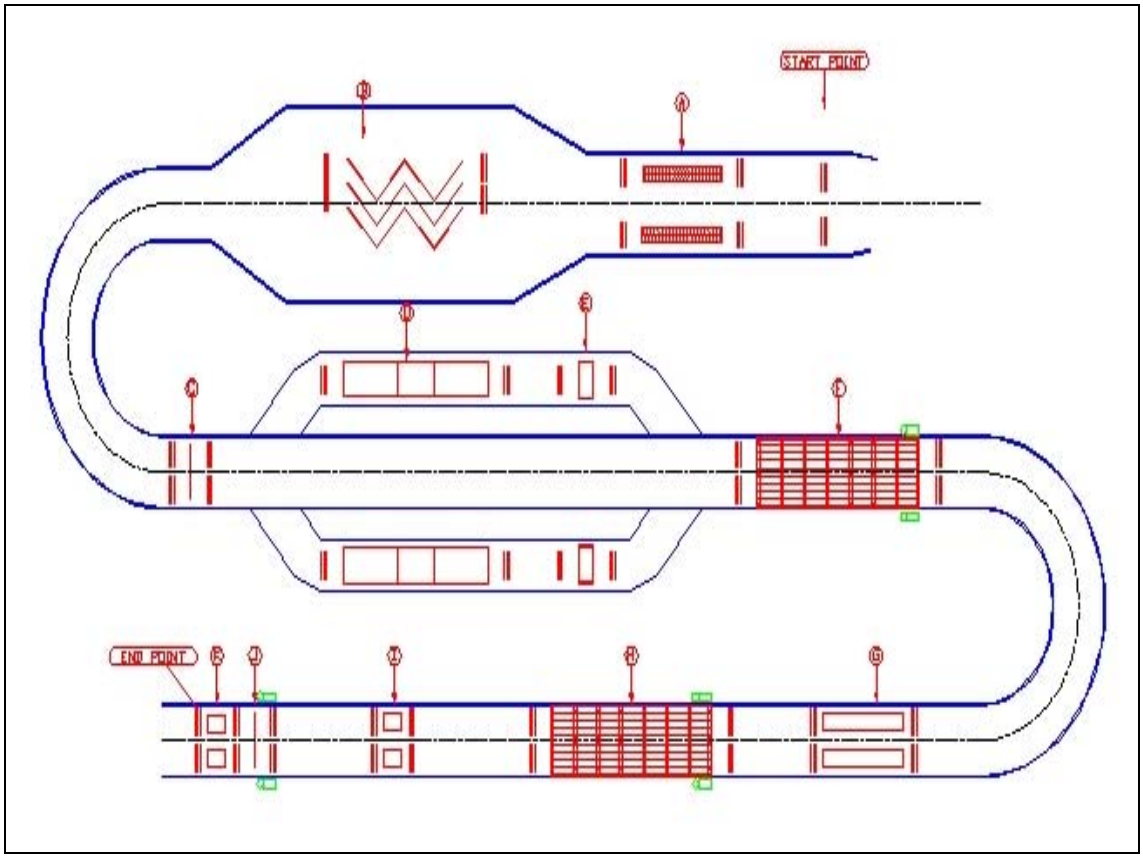
The helmet assembly has been fashioned to take into consideration weight and balance concerns and smoothed to eliminate scratchy or unsafe sharp edges.







Appendix C. Woodland IMT Course



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Appendix D. Human Factors Engineering Questionnaire Results

TRAINING

SAMPLE SIZE = 30

1. Using the scale below, please rate the training you received in the following areas.

1	2	3	4	5	6	7
Extremely bad	Very bad	Bad	Neutral	Good	Very good	Extremely good

	MEAN RESPONSE
a. Length of training	5.64
b. Level of detail	5.86
c. Sufficiency of training aids	5.96
d. Ratio of lectures to exercises	5.35
e. Training facilities	5.44
f. Hands-on exercises	5.92

Comments	No. of Responses
All the instructors were very knowledgeable of the equipment. They all answered my questions without any problems.	4
Overall, the training required more lecture than hands on. Input received from the instructors was excellent. I feel I am ready to don the equipment and begin the exercises.	3
Thought that it was very good hands on.	1
The training was short and to the point.	1
Clear and well-defined image on the ENVG.	1
Good basic overview of systems.	1
I liked the ENVG. It really brought out the heat. There was a big contrast.	1
What's cooler than learning about the latest night and thermal vision technology?	1
A little more practice before the use of the system would be helpful.	1
More time allotted for hands-on work with the ENVG and the PAQ4 system on the "rubber duck".	1
The helmet mount on the ENVG was not easily adjustable. Also I had a problem with the heat from my hand affecting the I-square image when I was focusing.	1

2. Using the scale below, how easy was it to learn setup and operate this night vision device?

1	2	3	4	5	6	7
Extremely bad	Very bad	Bad	Neutral	Good	Very good	Extremely good

MEAN RESPONSE
6.14

Comments	**No. of Responses**
Easy to set up.	3
System was very easy to operate.	3
Excellent introduction to the new "PVS-14". Instructor was quite competent. Unit was quite user friendly, as well as easy to adjust.	2
It doesn't take long to learn how to use the equipment.	1
Lightweight but extremely technical.	1
The ENVG was an excellent piece of equipment.	1
The baseline seems to be very easy to work with as far as setup goes. On the other hand, the SMaRTS seems to have a large amount of setup requirements (this in comparison to the baseline).	1
The ENVG and the SMaRTS seem very simple to adjust and operate. The brassboard, however, is very fragile and appears to be difficult to adjust and operate in the field (being a laboratory model). I would be afraid to trust the brassboard in the field.	1
The buttons and dials take some time to get used to.	1

3. Did the training and practical exercise time prepare you to use this night vision device?

24 Yes
1 No
5 NR

Needed more time to properly set up and adjust the system to obtain full benefits.	1

4. Did you notice any unsafe aspects of using this system at night and in a field environment?

3 Yes
24 No
3 NR

Comments	No. of Responses
Everything was very good I thought, but the brassboard was too big and had too many wires hanging from everywhere on the back pack. I think it will be easy for the wires to get hung on something.	1
The brassboard was very bulky.	1
The SMaRTS might need a safety cover over the IR illuminator switch to prevent the user from accidentally activating it. It could potentially draw fire to the user if the enemy has night vision equipment.	1

DEMOGRAPHICS

SAMPLE SIZE = 30

SEX	RANK	MOS	TIME IN SERVICE
Male = 30	E-1 – 6 PFC - 3	11B – 17 45K - 2	
	E-2 – 8 PV1 - 2	11C - 2 92F - 1	Mean = 12 months
	E-3 – 2 PV2 - 6	13F - 1 92R - 1	
	E-4 – 1 SPC - 2	25S - 1 96B - 2	
		25U - 2 97B – 1	

DUTY POSITION

CI - 1 RSC - 1 Intel - 1 Signal - 1
FO - 1 RTD - 1 Mechanic – 2 Student - 1
Infantry – 6 SATCOM - 1 Rigger - 1 NR - 13

1. Do you smoke? 12 yes 17 no 1 NR

2. Do you wear prescription lenses? 10 yes 20 no

a. If yes, which do you wear most often? 10 glasses 2 contacts
b. Which do you wear while firing a weapon? 10 glasses 1 contacts
c. What is your corrected visual acuity?

Right: 22 20/20 Left: 22 20/20
3 20/30 1 20/25
5 NR 2 20/30
5 NR

d. Which is your dominant eye? 25 Right 5 Left

3. With which hand do you most often write with? 28 right 2 left

4. With which hand do you most often fire a weapon? 27 right 3 left

5. What is your height? 70 inches (range is 66-75)

6. What is your weight? 170 inches (range is 130-205)

7. What was your last M4/M16 qualification rating?
2 Expert 7 Sharp 20 Marksman 1 NR

8. Have you ever boresighted an aiming light before? 12 yes 18 no

M16 with a PAQ-4 (4) M16A4 (4)
Aim point (5) PAQ-4 (2)
M16A4 with red dot sight (1) M16A2 (1)
M16 with a CCO (1)

9. Have you received previous training on firing with an aiming light? 17 yes 13 no

10. Have you ever boresighted a night vision goggle scope? 0 yes 30 no

11. Which night vision device do you use the most?
1 PVS-7 17 PVS-14 0 Other 12 None

12. How much time did it take for you to become accustomed to that night vision device?
21 Less than 1 hour 3 1-3 hours 1 2-4 hours 5 NR

13. Have you used any other night vision devices? 4 Yes 26 No
"Nightowl" 4x Monocular (1), NODs, PVS-5, PVS-14

14. What type of helmet do you typically wear?
1 ACH 27 PASGT 2 Other (Kevlar)

GRID LOCATION EXERCISE

SYSTEM/SAMPLE SIZE:

BASELINE ENVG = 30
SMaRTS = 30
BRASSBOARD = 30

1. Using the scale below, please rate your ability to perform the following tasks with this night vision device.

1	2	3	4	5	6	7
Extremely bad	Very bad	Bad	Neutral	Good	Very good	Extremely good

TASKS	MEAN RESPONSE		
	BASELINE ENVG	SMaRTS	BRASSBOARD
a. Finding center of target	6.07	4.87	2.50
b. Touching center of target	5.60	3.33	2.27
c. Focusing on target	6.00	4.80	2.40

Comments	**No. of Responses**
BASELINE ENVG	
Best of the three.	2
Very accurate.	1
Clear and true.	2
Easy to find.	2
This equipment was very good. It was lightweight and easy to learn. It took no time to use it and work it.	1
Task was easily completed using this system.	1
Field of vision was much higher than with the other two exercises.	1
Was able to focus and point with greater accuracy and seemed more of a mix of instinct and vision.	3
I felt much more comfortable with the baselines.	1
Basic awareness and focus felt close to normal.	1
I was much more successful trying to pin the tail on the donkey with the ENVG than what I was with the brassboard.	1
It was easier to find the center of the target using this device.	2
There was much less of a problem identifying the center using the I-square and mix versus the thermal.	1
Difficult to establish hand-eye coordination.	1

Comments	**No. of Responses**
It was difficult with the thermal vision to locate the exact center of the target. It seemed that the focus was off a little bit maybe due to a lack of time allotted for helmet adjustment. Other than that, the equipment worked very well.	1
When using IR and I2 together, I noticed that the IR source appears to be about an inch higher than the black dot.	1
Since baseline was focused on a more distant target by me, it was harder to fully be able to see the black square. The square also created a candlelight effect with the thermal vision.	1
The thermal showed a different spot than the night vision.	1
Very easy to find and focus, best system used.	1
When the thermal and eye square are both on, the thermal is a bit late on the target.	1
SMaRTS	1
I thought the equipment was very good and lightweight. It was easy to move around.	1
Center of the target was easily visible.	1
It was fairly easy to do using this system.	2
The light intensity setting was exceptional. If not for the problem with depth perception, then I believe I would have had no trouble touching the center target.	1
It took about a second to focus on the center dot. But after that second, it focused great.	1
The system illuminates extremely well, but it is hard to coordinate for close-up work. I think with practice, this wouldn't be as big of a problem.	1
It was much easier to see the center of the target as soon as I turned around as compared to the brassboard.	1
Practice using this device would most likely allow me to correct the slight offset to my privately owned vehicle.	1
Depth perception was off.	2
Depth perception on when trying to touch target.	1
Target seemed closer than it actually was.	1
Moving wasn't so great; moving made the screen blurry.	1
Each time I tried to touch the target, I was too low.	5
SMaRTS seems to completely lose focus for some reason. I figured it was the quick movement of the head to touch the target.	1
If view piece were larger, I may be able to better acquire the target. I found it difficult to see my arm pointing at the target, and usually pointed on instinct and then found my hand on the target board.	1

Comments	**No. of Responses**
Fairly difficult to quickly acquire target.	1
I found that on the screen there were lines on all settings. The lines did not make it difficult to focus but they were present.	1
It was difficult to get my hand-eye coordination together.	1
Very awkward looking through lens. I had a hard time negotiating simple tasks such as walking and pointing at small targets just a couple of feet in front of me.	1
BRASSBOARD	
Could not even see the board.	1
Difficult time finding the target. Seemed I had to turn more to my left to find the center of the target.	1
Difficult to focus on target distance and center point. Helmet seemed to be part of the problem.	2
While subject acknowledges that this is a prototype of the brassboard, it was pretty much near impossible to focus and sometimes locate the target.	1
The NG's were blurry/white until they were able to focus.	1
Hard to focus.	3
Difficult to distinguish different objects.	1
Found it difficult to locate target on the grid with very little depth perception.	1
Extremely impractical!	1
Horrible clarity, horrible weight, horrible contrast, horrible unit.	1
Lights were real bright but clarity was horrible.	1
I could barely see the little black dot.	3
It was hard to see the center of the target right after I turned around, but it became easier to see after I touched the board.	3
Very difficult to see the target, low resolution on display. Very difficult to discern different objects and people.	1
I don't believe that the device had enough time to register the motion of turning (though that might be what is being tested).	1
When turning, there was a lot of motion blur; that was somewhat dizzying.	2
I had to adjust between thermal and I-square. I was able to focus on the target much better than with the SMaRTS.	1
I would have been better off without the brassboard. It might have been positioned on my head wrong, but I couldn't see ANYTHING!	1

Comments	**No. of Responses**
It was nearly impossible for me to locate a close-up target or decipher anything that I was looking at through the actual sight. It felt like I could see a lot better without the sight than with it on. Far-away objects were easy to make out.	1
Kind of lower and right.	1
The imaging on the brassboard took a few seconds to focus on an up-close objective.	1
The whole picture seemed off center in the monitor of the brassboard.	1
This task was harder. The equipment was heavier.	1

2. Did you notice any magnification the system may have provided during this exercise?

	BASELINE ENVG	**SMaRTS**	**BRASSBOARD**
Yes	7	9	10
No	23	21	20

3. What are your comments on your capability to complete this exercise wearing this device?

BASELINE ENVG

I felt much more confident with my depth perception using this system.	1
Target detection was easiest using this system as well.	1
Easiest and best system used.	4
This system looks most like the way a person would really see things, so this was the easiest system to use.	1
This was by far the easiest of the three to use, and it provided the best night vision and thermal imaging; I had no problems with my depth perception.	
I found this a good system and it had a strong ability on focusing on the target.	2
I had a much easier time touching the center point using this device than with the other two.	1
Pinning the tail on the donkey was a lot easier this time. My focus along with my thermal was good this time. I much prefer the ENVG over the brassboard!	1
I liked the ENVGs much better since the field of vision was much greater.	1
With thermals and the mix, there as a slight offset on the display, but it was very easy to orient myself to the unit.	1
The knobs were in good positions to use.	1

Comments	**No. of Responses**
The night vision was great and the infrared was great as well. I have no complaints about this system.	1
The target was very sharp and easy to find.	1
Proficient.	1
Vision was just as good as wearing nothing at all.	1
Went very well; I touched the point I wanted to touch.	1
With this one I could actually hit the point on the grid.	1
The thermal did not modify fast enough to get a clear picture of where the center is.	1
The thermal and thermal-NV mixed were a little bit shaky. There wasn't much time for adjustment for my eyes to the equipment or adjustment of the equipment to the helmet.	1
The night vision was on target once focused, but the thermal showed the target one grid square higher than the night vision. The system helped identify the target easily, but the thermal was off a bit at the short distance.	1
The target was a little out of focus since I was standing so close to it, but everything farther away was in focus perfectly.	1
One thing that I don't like about the device is that to turn the knobs on or off, it is in different directions. In combat if I needed to turn the ENVG on in a hurry I might forget which knob turns which way.	1
SMaRTS	
The picture was very good.	1
Made finding the target pretty easy.	1
This helmet fit much better than the brassboard system and it was much easier to see the center of the target as soon as I turned around. I like this system much better than the brassboard system.	1
I prefer the light intensity of the SMaRTS versus that of the brassboard and baseline.	1
It appeared that my depth perception was a little off centered when using this device; however, that was easily overcome once I became aware of the problem and was able to compensate.	1
After the first time I tried to touch the dot, I tried to compensate for the difference between the actual location of the dot and where my brain said it should be.	4
Need to be aligned with the natural sight or try to make it aim a little bit higher.	1
Did not like the screen compared to the baseline because the square mixed in the darkness around it with the SMaRTS and felt harder to complete the task.	1

Comments	**No. of Responses**
Horizontal lines on thermal made it difficult to identify target.	1
I noticed some minor "scope shadow" on the top of the screen when looking down at a 45-degree angle that increased at steeper angles.	1
In the screen of this device, the top right corner was blurry.	1
My up-close and distance vision seemed right on line with my vision without the SMaRTS.	1
The depth perception was a problem and the gray made it difficult to identify objects with the light gray and dark gray.	1
The device did not allow me to see other objects when pointing and turning. It was difficult to find my hand and arm when moving to point at the target. Image was very blurry when moving my head and the exercise seemed more of an instinct on my pointing,	1
Sat higher on your head so you had to guess a little bit.	1
This system was outstanding. It turned night into day. Everything was crystal clear. One thing I discovered was that I had to get used to the change in my depth perception.	
You need time and no movement for this device to work effectively.	1
BRASSBOARD	
The device was much more compatible with my field of vision; however, the screen was very small and was not centered properly over my eye. I was able to find the target as I was moving my hand to it during the exercise much better than with the SMaRTS.	1
Anything I look at close I can't even see. Anything far away looked like a blob.	1
As far as pointing out the black dot, I would have been better off with just my eyes.	1
Could not observe any magnification from the night vision device because I had bad perception of depth caused by the device.	1
The brassboard didn't work well for me. I couldn't see anything. I'm not sure if it was just positioned wrong on my head or maybe because I'm right eye dominant and not left. Either way, my experience with the brassboard wasn't good.	1
Everything appeared to be lower than where it actually was due to the camera on top of my head. It was difficult to see and when it came to turning and pointing it was almost impossible to do so without wanting to re-adjust my hand to the board.	2

Comments	**No. of Responses**
Everything seemed off centered and my depth perception was entirely screwed up, it was hard to compensate for this and my attempts at such still proved rather futile.	1
It was difficult to focus, navigate, and point to the dot using the device. The image appears good when I can look at a 3- to 4-foot distance and don't have to move.	1
It was hard to find the targets on the board.	1
Found it difficult to locate target on the grid with very little depth perception.	1
The 50/50 was hard to see with night vision; hard to distinguish between the light gray and dark gray.	1
Helmet was uncomfortable and unwieldy.	1
I had a hard time even trying to walk. Brightness was real dark but lights were real bright.	1
I think the helmet was a little big for my head and I think that it would have been easier if the helmet would have fit properly.	1
Image seemed too high on the reticle.	1
It took time to focus on the target.	1
It would have been hard to complete the obstacle course with the brassboard.	1
Obviously needs a lot of work.	1
Seemed slightly larger than real life on the screen, no huge difference though.	1
Took a few seconds to adjust when completing an up-close objective.	1
The entire system was clumsy and it took way to long to set up. It was also very hard to adapt to the system.	1
The image shown throws you off to the left.	1
There appeared to be a very slight magnification. The brightness of the horizon made everything in the foreground a silhouette and it took a moment for my eyes to adjust to closer objects afterwards. The detail of objects was very low in this system.	2

WOODLAND IMT COURSE

SYSTEM/SAMPLE SIZE:

BASELINE (NO EYE COVER) = 30
SMaRTS (NO EYE COVER) = 30
SMaRTS (EYE COVER) = 30
BASELINE (EYE COVER) = 24

1. Using the scale below, please rate your ability to perform the following tasks with the goggle you used.

1	2	3	4	5	6	7
Extremely difficult	Very difficult	Difficult	Neutral	Easy	Very easy	Extremely easy

TASKS	MEAN RESPONSE			
	BASELINE (NO EYE COVER)	SMaRTS (NO EYE COVER)	SMaRTS (EYE COVER)	BASELINE (EYE COVER)
a. Negotiating the zigzag	6.10	5.34	3.83	5.25
b. Negotiating the 2-foot wall	5.83	5.31	3.83	5.83
c. Negotiating the mound	5.97	4.97	3.57	5.75
d. Negotiating the foxhole	5.83	5.00	3.37	5.71
e. Negotiating kneeling firing position	6.37	5.83	4.73	6.29
f. Negotiating the 4-foot wall	5.93	5.21	4.40	5.75
g. Negotiating the stair platform	5.47	4.77	2.97	4.88
h. Climbing through the window	5.57	4.83	3.47	5.50

Comments	**No. of Responses**
BASELINE (UNAIDED EYE NOT COVERED)	
Everything easily done.	4
The tasks were easy and I could see well too.	1
Very straightforward system	1
Everything was simple and natural.	1
Best thing ever.	1
Really clear and really defined.	1
Depth perception was accurate. It was easy to identify terrain variations and other trip hazards.	1
No problems, system worked really well.	1
Not very difficult. I was only confused once, when I saw a strange thermal image right after negotiating the hole in the wall. It was probably the thermal "test pattern" overwhelming the I2 when I looked at an area that was darker than the rest.	1
Task easy until looking down at stairs.	1

Comments	**No. of Responses**
The only hard part was seeing objects below me.	1
The ENVG with vision through both eyes was much better. I'm still not a huge fan of the thermal on the ENVG. I still have to focus on an object just right before I can see it real well with the thermal.	1
The system was decent for negotiating all the obstacles, but it was difficult due to the helmet sliding around. I attribute this mostly to the ballistic helmet rather than the actual ENVG system, but it could have been due to poor mounting.	1
Any task where I had to look down was harder to achieve because the night observation devices (NODs) slid around on Kevlar.	1
Course proved difficult only when the device came out of adjustment during the exercise.	1
The unit has an orange tint along the top edge of the device when looking through it, which hindered depth perception.	1
Depth perception wasn't as bad as eye closed, but it was still a problem.	1
Had a problem with staying centered on the eye.	1
I had to move slower than normal. I think it's mainly because I'm not used to wearing night vision.	1
SMaRTS (UNAIDED EYE NOT COVERED)	
The task was done fairly easily.	1
Too easy with my other eye opened.	1
Tasks were much easier while being able to use my unaided eye. It allowed for better depth perception.	1
A lot easier and faster without eye patch.	1
The helmet shook so much during fast paced movement that I could not focus on the display unless I slowed down and most objects were lit enough to see without the SMaRTS system. I negotiated most of the course without the aid.	1
Stationary it was very clear, but moving made it blurry and difficult to navigate.	1
Bouncing off display was distracting.	1
It moved around too much and it was hard to adjust.	1
Fairly hard to see darker colored objects, not very much contrast.	1
Since I am left eye dominant and the system was set up for the right eye, my left eye kind of took over and there was enough moon light for me to do the course quickly.	1
Images take time to display. If soldier moves too fast, the video may not show as fast as it needs to.	1

Comments	**No. of Responses**
It was very difficult to do any of the tasks and I found myself actually looking out of my open eye rather than out of the system as that was the only way I could get through the obstacles. It seemed like the system would not adjust very quickly.	1
Mound was nearly impossible to be able to tell the elevation of different points. At some points, I was having a hard time telling if I was going up or down on the mound. Telling the distance of an object during all of it was complicated also.	1
Not difficult, except I had a little disorientation when I went over the stair platform, because the helmet was swinging from side to side. I closed my aided eye a couple of times in order to navigate the run, because the view disoriented me.	1
Picture blurry while in movement.	1
Screen difficulty when I'm running.	1
The largest problem was managing to keep the lens in front of my eye. When the lens was there, moving and seeing were not that difficult. The size of the helmet would make a difference.	1
This was a little more difficult.	1
Very difficult to see clear.	1
WOW! I noticed a tremendous difference between the SMaRT and the ENVG. Granted I had my eye covered on the ENVG but I'm certain that had my eye been covered on the SMaRTS, I would have still noticed a HUGE difference compared to the ENVG.	1
SMaRTS (UNAIDED EYE COVERED)	
Overall fine.	1
I felt comfortable with my depth perception, but it was clearly not accurate.	1
The image was great. The blending of the night vision sensors works very well.	1
One down point is that everything is in a different spot than where it looks to be.	1
The weight of the system caused the helmet to shake significantly while I was running.	1
It was extremely difficult to move through and a hard fall in the foxhole jostled my helmet, making the rest of the tasks even more difficult to complete. The goggles didn't adjust very well and I wasn't very happy with their performance.	1
After swan diving into the foxhole, it led me to believe that depth perception on the SMaRTS with a patch is not very good.	1
Depth perception extremely difficult.	7
Darker colored objects had trouble showing up on the screen.	1

Comments	**No. of Responses**
Depth perception became a problem negotiating the staircase, the doorway, and the 2-foot wall. Downward vision for better depth perception would increase the ability to carry out this task.	1
Hard to make anything out while running.	1
Helmet moved a lot, causing it to be difficult to see. Had to move slowly. Still had some difficultly seeing at times while moving.	1
The hardest part of this was not having a helmet that fit well on my head; I was constantly adjusting the system due to the bouncing of the helmet on my head.	1
It's kind of hard to move faster.	1
The goggle's clarity worsens with movement.	1
In the tasks that were difficult, I couldn't determine distance very accurately.	1
Low obstacles were difficult to negotiate because focusing your attention downward while trying to move forward was not natural (similar to running with your head down).	1
Moving was very hard to see.	1
Screen and goggle need to be bigger.	1
My sense of surrounding awareness was low and so was my vision.	1
Task became hindered without the use of my unaided eye.	1
The SMaRTS threw off my depth perception, so that I fell into the foxhole and tripped on top of the platform. I had the straps tightened down better, so the device didn't swing as badly as it did on the last trial.	1
This system was certainly more difficult with the eye patch on.	1
This task was difficult, but not that bad. It was difficult at times when there will be a shadow on the field. There isn't enough color or light to tell apart areas on the field.	1
This was a huge difference from the SMaRTS with the open eye. Everything seemed so hard. It was very hard to get good focus on the entire obstacle course in general.	1
Seemed height and depth perception (i.e., going up and down the mound and the steps) caused vision to be a bit distorted.	1
BASELINE (UNAIDED EYE COVERED)	
Very clear. Much easier to see.	1
Very straightforward and fairly easy.	1
Baseline works great. I can perform almost as well as if it was daytime.	1
No difficulty at all. It was too easy!	1
Easy viewing from actual eye level.	1
Tasks relatively easy due to greater depth perception.	1

Comments	No. of Responses
I have some experience with the PVS-14 so this course was a little easier with the ENVG.	1
My depth perception took a little getting use to, but other than that, the task was easily done.	1
Everything was good enough and thanks to the basic ENVG I was able to finish the course.	1
Tasks seemed to be easier to complete with eye covered in the sense that I was able to completely focus on the aided eye and not try to perceive the events around me while combining both eyes.	1
The tasks were easy because I had a pretty sharp picture. If I had a better helmet to go with the system I would not have any complaints.	1
Vision lost a little from covered eye but was still able to negotiate the course rather easily.	1
It was all fairly easy except I was a little hesitant about climbing through the window due to not being able tell where my feet were very well.	1
The eye patch reduced depth perception. It was still accurate enough to complete the course effectively.	1
Depth perception was all screwed up. I could navigate but with limitations on how close I was.	1
It was harder to perform the task with my unaided eye covered. I misjudged the location of the 4-ft wall slightly and stumbled coming down the hill. I had a little trouble locating the kneeling firing position, even though I knew where it was.	1
My depth perception was a little off on the stairs and the window.	1
My helmet became a little bit loose on my head and had the vision square been in the most comfortable position for me, I would have had no problem at all.	1

2. Using the scale below, please rate the following characteristics of the goggle system you used.

1	2	3	4	5	6	7
Extremely bad	Very bad	Bad	Neutral	Good	Very good	Extremely good

CHARACTERISTICS	MEAN RESPONSE			
	BASELINE (NO EYE COVER)	SMaRTS (NO EYE COVER)	SMaRTS (EYE COVER)	BASELINE (EYE COVER)
a. Location of controls	5.93	6.03	6.23	5.46
b. Ability of controls to retain settings	5.77	6.00	6.07	5.79
c. Size of controls	5.87	6.43	6.17	5.75
d. Stability of helmet mount	5.20	5.20	5.27	5.46
e. Balance of goggle on helmet	5.20	5.33	5.33	5.29
f. Wearing comfort	5.27	5.83	5.55	5.21
g. Cable routing on helmet	5.74	6.07	5.88	5.82
h. Weight of goggle	5.57	5.20	4.90	5.63
i. Shape of goggle	5.87	5.43	5.27	5.83
j. Size of goggle	5.67	4.97	5.20	5.79
k. Adequacy of field of view	5.57	4.21	4.40	5.67
l. Ability to perceive depth	5.40	4.03	3.23	5.29
m. Sight picture brightness	5.93	5.30	5.20	6.00
n. Sight picture clarity	6.03	4.83	4.70	6.04
o. Overall goggle performance	5.87	4.67	4.20	5.83

Comments	**No. of Responses**
BASELINE (NO EYE COVER)	
Great.	3
Good lighting, weight, comfort and picture.	1
The goggles performed extremely well.	1
Night vision was clear. Everything worked well.	1
These are the best of the three tested.	1
When I was running on the course, the goggles didn't move or bounce.	1
Brightness and clarity good (until fog).	1
I think that if the ENVG were a little sturdier, like on the SMaRTS helmet, it would be much better. The thermal could use some improving. Other than that, the ENVG is a pretty good system.	1
It's a great night vision picture, and I like how the thermal shows me only what I need to see (if there is no heat, then it's all green).	2
The colors and contrasts of this system are the easiest for my eye to adapt to. It also gives the best sense of depth perception.	1

Comments	**No. of Responses**
Just takes a little getting used to.	1
Nice pieces of equipment but a little shaky while I'm running through the course.	1
The field of view is not the 180 degrees I would prefer, but I'm happy with them. I foresee problems if the wearer has to travel while flares are intermittently going off overhead.	1
Although I found fewer problems with depth perception in comparison with the SMaRTS, it still gave me trouble with negotiating obstacles that required me to jump.	1
Bit of a tedious job to adjust controls and picture of it.	1
Thermal image took time to catch up with I-square.	1
Goggles fogged up during the course.	1
Weight makes the helmet move when I'm running. Bulk and weight limiting factors under intense movement.	1
Picture was not as bright as I would prefer. Unit controls ability to retain position from eyepiece to my eye was extremely poor. Had to continually manually adjust unit while navigating the course. Orange tint made depth perception lower than expected.	1
Still seems pretty dark. Goggle would not stay centered on the eye, maybe because the helmet was moving.	1
SMaRTS (NO EYE COVER)	
The SMaRTS was amazing. It felt as if I were seeing the light through both eyes! Everything was much clearer as compared to the ENVG. Thermal was great on the SMaRTS system. I didn't have to focus on the object to notice the thermal.	1
The night vision was excellent. It turned night into day.	1
The system is a great improvement compared to the PVS-14.	1
Using thermal or baseline goggles makes it easier to tell depth or distance of targets.	1
The ability to see was good but keeping the lens over eye was difficult.	1
The view is very sharp when stationary, but the picture is hard to understand when I'm running due to swinging and changes in brightness of the surroundings.	1
Picture was great when stationary, but moving was terrible. Movement was blurry and the weight made it bounce around too much. Goggle should be a little bigger.	4
Before I started the course when I was adjusting the settings I was able to get a clear crisp image as long as nothing was moving. As soon as I started to move, the image became blurry and had trials.	1

Comments	No. of Responses
I had to slow my run down a few times to stabilize my picture. The screen shook around a lot and part of it was because of an unstable helmet.	1
I think this would have been much easier if I had the proper size helmet. I had to hold the helmet with one hand the entire time in order to get a good picture on the screen.	1
Could not find a setting that would be useful to me for navigating the course. Adjusted settings during the run to see differences while negotiating the obstacles. Unit's brightness is not up to par. Unit's view is not adequate to perform the task.	1
I didn't think that the goggles were very effective at all. I would rather have nothing than to use this product while in a hostile situation or while trying to maneuver any type of obstacles.	1
It is uncomfortable on the eyebrows.	1
It moved too much so I couldn't really see unless I looked with my other eye.	1
The depth perception is offset (after corrections) hindering my ability to negotiate all obstacles that required me to jump.	1
Thermal lag makes movement difficult.	1
They were fine, but I found myself using them a lot less with my other eye opened.	1
Very hard to use while moving, helmet moves around too much and there is nothing but blurriness while moving with this system. Found myself relying on my open eye for the most part.	1
SMaRTS (EYE COVER)	
Most comfortable and easiest to adjust.	1
Nice but could have more clarity.	1
The system performed well.	1
SMaRTS is the better of the two I have decided on sight quality.	1
The system on the helmet is set up very well and comfortable.	1
The night vision of the goggles worked well but while negotiating the obstacles it was jostled and wouldn't adjust to what I was seeing very well. I would never use these in a combat situation.	1
It's heavy and unstable but it has a pretty good sight.	1
Field of view and picture clarity were very good except for when I was running. While running, the picture got blurry enough to where you would have to walk.	5

Comments	**No. of Responses**
Unit's depth perception could be greater with the aid of lower vision. I could not acquire adequate depth perception due to my lack of ability to see my feet. If I could gauge that distance, my overall depth perception would allow me to better navigate.	1
Bad depth perception.	5
Somewhat difficult to perceive depth and objects that were not brightly colored were hard to see.	1
Lack of peripheral vision.	1
SMaRTS was slightly slower than real time. There was a pause or lag in the display. Also a shock to the system (i.e., a jump) caused a flash in the display.	1
The black-and-white picture didn't fair well with me because of the picture quality.	1
BASELINE (EYE COVER)	
Clear view and excellent brightness.	3
Depth perception was better than other systems.	1
Much easier to see objects and negotiate course.	1
Really good night vision and thermal device.	1
The vision made the field easy to do.	1
I was able to see every obstacle that was ahead of me.	1
It is a good setup a clear picture and thermal picture.	1
This helmet fit much better than the SMaRTS, so obviously I believe this performed better.	1
This system worked much better than the SMaRTS.	1
Clarity and the color contrast of the green and the orange worked much better than the black and white for helping me understand the picture.	1
Was able to properly adjust the helmet and equipment of the ENVG during this run. Image was good overall. Field of vision allowed me to better perceive my position and depth/distance from obstacles (I could see my feet).	1
Wasn't as bright as I expected, but it was darker than I thought.	1
Depth perception was still an issue but there were no problems with the position adjustments with the goggles (using same goggles as in the previous questionnaire).	1
Front heavy.	1
I had to shut off the IR in the area of the hole in the wall in order to see. (I originally ran a 50/50 mix.) When I entered an area that was darker than the rest of the course, the IR display overwhelmed my vision and made it harder to see.	1

3. How would you describe the I2-thermal mix you used for this trial?

1	2	3	4	5	6	7
100% I^2	Mostly I^2	Slightly I^2	Equal mix	Slightly thermal	Mostly thermal	100% thermal

MEAN RESPONSE			
BASELINE (NO EYE COVER)	**SMaRTS (NO EYE COVER)**	**SMaRTS (EYE COVER)**	**BASELINE (EYE COVER)**
2.37	2.69	2.69	2.12

Comments	**No. of Responses**
BASELINE (NO EYE COVER)	
Excellent on both, terrain features easier to see with thermal turned down.	1
Great.	3
The I-square clarity was great though. It was very comparable with the SMaRTS.	1
The thermal help aided the night vision, because the thermal will bring something to your view and attention that you might have missed.	2
Thermal vision was excellent. Always helped and never got in the way.	1
The I2-IR mix worked very well, except one time when I entered an area that was darker than the rest of the course. Then the IR "test pattern" overwhelmed the I2 and I wasn't able to navigate for a couple of seconds.	1
The mixture was nice because I could see things extremely well with the thermal, but if I would have only had the I2 on, I would not have been able to see the objects very clearly	1
Slight lag on the thermal only, the I-square is fine.	1
It was decent. But the thermal is not too good on the ENVG.	1
I think the thermal is good to use in some situations but I would definitely prefer I-square.	1
I didn't like looking through the thermal. They are very useful to have while scoping out terrain but while conducting obstacles like that I would prefer just to have I square. The thermal is very useful, however, due to the ease of adjustment.	1
I didn't feel any need for the thermal on this one, since the I2 came in so bright.	1
It was harder with the thermal because you had to look to the side to get better focus.	1

Comments	**No. of Responses**
SMaRTS (NO EYE COVER)	
This was awesome. My entire picture was so clear thanks to the I-square and the thermal was great. I could see every person that came across my picture. It was very easy to depict every obstacle. Compared to the ENVG, this was much better.	1
Good mix of thermal and I-square. The concept allows for better target acquisition, but not useful in close quarters navigation of obstacles.	1
A 65-35 mix seemed to give me the best view.	1
Awesome; it was a fairly clear picture.	1
Best setting 75/25.	1
I liked this mixture much better than the 50/50 ratio.	1
Never seen this before. I was very impressed to see both of them mixed and with little to no difference in picture.	1
Didn't really stay in place.	1
I think the mix needs to have a more definite separation; when the setting is on black for hot I can't tell the difference between a dark spot and a hot spot. And when white is hot there isn't as sharp of a picture.	1
The black/white contrast of the system makes it easy to identify outlines on most large objects; smaller objects are very difficult to detect while moving.	1
Thermal not very distinct.	1
SMaRTS (EYE COVER)	
Great.	2
Decent.	2
Easily adjustable and I could find a good picture that I liked.	
The ability to choose your own mix is very user friendly.	1
I used a 35-65 mix. I would have preferred a 100% thermal mix, but the 35-65 was the best mix in the area of 50-50.	1
Makes for a clear image.	1
I like the thermal on the SMaRTS and the I-square clarity too. But when I had the patch on my non-dominant eye, everything went bad. I would definitely hate to be THIS way in a hostile situation. It was very hard to navigate my way around the obstacles.	1
One thing I did not like was since the thermal was blended with the night vision, the thermal "trails" were very distracting when moving through the course.	1
Used 40/60 mix of thermal to I-square. The thermal image selector was set to show black thermal images which allowed greater overall brightness. However, if trying to acquire a target in a wood line at a great distance, you would need to change the select.	1

Comments	**No. of Responses**
BASELINE (EYE COVER)	
Both worked well together.	1
Easier to see terrain features with the thermal turned down, even with low thermal able to clearly identify people at moderate distance.	1
Good for determining people from objects but annoying when moving.	1
The thermal helped the night vision on running through the field easily.	1
I can't wait to use it in the future. I myself haven't noticed any but very minor and petty flaws.	1
I liked the green and orange mix.	1
I liked this ratio much better than the 50/50 mixture. I think it was a lot easier to see everything with this mixture	1
I preferred I-square to thermal.	1
I've been hoping the PVS-14 would soon be teamed with the thermal and the accompaniment far exceeded my expectations.	1
The 50-50 mix worked until I entered an area that was darker than the rest of the course, and I had to shut off the IR in order to see.	1
The combination was useful. However, I had a more difficult time noticing the thermal while on the move. Once I got into place and was in more of a steady position the thermal was a lot more useful.	1
Was able to better negotiate the course using only I-square.	1
More I-square than thermal.	1
The thermal was slightly behind real-time. It was kind of awkward that the I-square image was fully on time and the thermal image not.	1
The thermal messes my depth perception up.	1

4. Did you experience any of the following problems during this trial?

	NUMBER OF RESPONSES			
	BASELINE (NO EYE COVER)	**SMaRTS (NO EYE COVER)**	**SMaRTS (EYE COVER)**	**BASELINE (EYE COVER)**
Eye strain	1	5	6	1
Tunnel vision	3	4	7	5
Headaches	0	1	0	1
Motion sickness	0	0	1	0
Nausea	0	1	0	0
Disorientation	3	8	12	2
Dizziness	0	1	2	1
Lens fogging	4	2	2	2
Screen white-out	0	4	3	1

Comments	No. of Responses
BASELINE (NO EYE COVER)	
Lens fogging cleared as soon as I started my run.	1
Lenses fogged up during the course.	1
Stability of unit and headgear (helmet) made the device move considerably.	1
Telling what was below my feet.	1
The position adjustments of the goggle continuously changed causing me to use my unaided eye from time to time.	1
The thermal sometimes got in the way of the actual vision due to it being far more blurry than the I-square and the goggle was shaky on my head. Other than that, they worked very well for what they are intended to do.	1
With prolonged usage I can foresee eyestrain. Headaches might also be caused by the level of tightness of the helmet to keep the ENVG stable.	1
SMaRTS (NO EYE COVER)	
All went well.	1
Lens was fogged when I donned the unit, and it fogged up nearly completely by the time I finished the course. Made visibility through the SMART unit extremely unsatisfactory.	1
No detail or clarity while moving.	1
Screen did not actually white out but went black for 3 to 5 seconds twice during the obstacle.	1
Weight and stability.	1
SMaRTS (EYE COVER)	
Good overall system, sits VERY well on the head, good weight, depth perception and brightness need attention.	1
After taking the goggles off, had some tunnel vision.	1
Disorientation was overcome in less than 2 minutes. Physical and mental adjustment to allow for proper movement and balance.	1
I began to feel dizzy with the patch on. It was more a balance problem but it was borderline dizziness.	1
I tended to run more slowly while negotiating obstacles, so that I could feel them with my hands. I tended to trip when I had to trust only my feet.	1
I think this task would have been easier if the helmet was the proper size. I had to hold the helmet up with one hand in order to get the best picture in the goggle.	1
They worked OK in the beginning other than the fact that there was little to no adjustment and I had to move very slowly through the course to prevent collision with obstacles.	1

Comments **No. of Responses**

BASELINE (EYE COVER)

Did not put the thermal imaging system on for this run through the course. 1
I got dizzy only when I took the device off. 1
Lens fogged very badly when not moving. 1
Lens fogging occurred prior to beginning the obstacle but was of little problem during and after the exercise. 1

5. Was there anything unsafe about negotiating the IMT course?

	NUMBER OF RESPONSES			
	BASELINE (NO EYE COVER)	**SMaRTS (NO EYE COVER)**	**SMaRTS (EYE COVER)**	**BASELINE (EYE COVER)**
Yes	1	4	8	3
No	28	26	19	21
NR	1	0	3	0

BASELINE (NO EYE COVER)

Everything was good. 1
Falling and tripping. 1

SMaRTS (NO EYE COVER)

Depth perception made negotiating the stairs and mound difficult. 1
Falling and tripping. 1
Unit's brightness settings seemed to change when approaching any obstacle, making depth perception change drastically. 1
Very hard to see where you are going when moving. 1

SMaRTS (EYE COVER)

Depth perception. 3
Not being able to view my feet hindered my negotiation of the staircase especially. If the view would include lower peripheral vision to allow one to see their feet, depth perception would be greatly improved. 1
Didn't like moving with it on, hard to get your sight picture back. 1
Even though I nearly face planted into the foxhole, it was my responsibility to make sure I was going into the foxhole correctly and not an actual issue with the IMT course. There is positively nothing unsafe about the IMT course. 1
Difficult to determine holes, particularly their depth. 1
Falling and tripping. 1
The stairs and the foxhole were somewhat difficult to negotiate. 1

Comments	**No. of Responses**
When I ran with this system, all vision went bad.	1
If there was an accident the equipment is most at risk.	1
It's hard to keep tracking of some stuff on the course.	1
BASELINE (EYE COVER)	
Everything seems to be alright.	1
Depth perception was tricky but easy to overcome.	1
Falling in holes and tripping on obstacles.	2

6. Did this night vision device adversely affect your situational awareness while completing this exercise?

	NUMBER OF RESPONSES			
	BASELINE (NO EYE COVER)	**SMaRTS (NO EYE COVER)**	**SMaRTS (EYE COVER)**	**BASELINE (EYE COVER)**
Yes	7	8	17	4
No	23	22	13	19
NR	0	0	0	1

BASELINE (NO EYE COVER)	
Good as normal.	1
Made it better.	1
Concentrating on fogging rather than situation I was in, very distracting.	1
Depth perception and the position adjustments caused me to continually adjust my movements (shadowing or compensating an obstacle).	1
I noticed the tendency to watch my feet, rather than my surroundings. It tended to give me tunnel vision.	1
Unit moved considerably while negotiating the course. Having to take my hands off my weapon to adjust the sight caused me to slow my pace until unit was satisfactory once again.	1
Was better than SMaRTS/unaided eye open.	1
SMaRTS (NO EYE COVER)	
Very good stationary.	1
Not as good as with baseline but still pretty good.	1
Using the unaided eye with the system there was no problem.	1
Bigger goggle to see more.	1
Distance and acknowledging things were harder.	1
Does not allow a constant for visibility and target acquisition abilities.	1
Due to a problem in the depth perception, I would be shadowing anything with which I came in contact with.	1
I spent more time trying to keep from tripping myself than paying attention to my surroundings.	1

Comments	**No. of Responses**
I was worried I was going to hit something or fall in a hole.	1
It was hard to see what I was doing most of the time and targeting at a run/stop pace was impossible.	1
Yes it did affect my situational awareness when I tried to concentrate on the display more than my surroundings.	1
SMaRTS (EYE COVER)	
It was probably the best for my situational awareness but the depth perception was bad.	1
Depth perception and vision blurring. Too worried if I was going to run into something, which I did multiple times.	1
Only at close ranges. Vision and movement while looking at greater distances was much easier and faster than the ENVGs.	1
Didn't know where anything was unless I slowed down a lot.	2
I was moving too slow and that can be a risk on any mission	1
In order to get a precise picture and awareness, I would need to stand still. This makes it very difficult to complete the obstacle course in a realistic time frame.	1
Distance was hard to perceive.	1
I couldn't really tell what was going on around me.	1
I definitely had to concentrate on the system and not as much on my surroundings.	2
I had to focus a lot on making sure I knew where I was stepping which greatly reduced my alertness.	1
It made you feel as if you were controlling a video game.	1
No peripheral vision.	1
BASELINE (EYE COVER)	
Great.	2
Having an unaided eye closed seemed to help completely focus on things around me better than with it open.	1
It made finding foot-holds easy on the hill and finding the steps on the field.	1
Situational awareness was not affected.	1
Was able to navigate the course without having to adjust my equipment.	1
When my screen whited out, I was nearly blind for several seconds.	1

7. Any further comments concerning the night vision device you used and your ability to do these tasks?

BASELINE (NO EYE COVER)	
By far the best.	3
Very good system.	1
I like them a lot more than the ones I used in basic.	1

Comments	**No. of Responses**
I thought this device worked really well.	1
Lightweight and the easy access to the controls.	1
SMaRTS controls are much better than ENVG, but the ENVG actual quality of picture is better.	1
Weight and bulk only limiting factors.	1
With more experience, I believe I could overcome the tendency to watch my feet and watch my surroundings instead.	1
SMaRTS (NO EYE COVER)	
Everything went well.	1
If I had to choose between the ENVG and the SMaRTS, I would most definitely choose the SMaRTS. It almost felt as if I were moving in plain daylight. This system was very useful as well as helpful in completing the IMT course.	1
System needs improvement. Great clarity while standing still, but while moving is more of a hassle than a help. I would rather run through the woods wearing nothing more than a SMaRTS at this point. Very comfortable helmet design though.	1
Using this unit does increase night vision capabilities.	1
To use the system to its fullest potential I would say that the user would have to be stationary.	1
Didn't really like these goggles because I thought they were unsafe.	1
Having the lens move while you were moving made it difficult for the lens to stay over the eye.	1
I could probably perform better with the equipment with more practice.	1
It's good but I prefer baseline.	1
They stank!	1
Unit needs to adjust for a better overall view and brightness constants. View and brightness do change, affecting depth perception and speed of negotiation and traveling.	1
Very hard to see things. All I mostly saw were black and grey colors.	1
SMaRTS (EYE COVER)	
Overall, the unit is much better than the ENVGs.	1
SMaRTS access to its controls is by far better than the other NVGs and the sight picture is almost as good. Perception is the biggest problem with it but that was only with the unaided eye covered. Helmet is a bit complicated.	1
A lighter model would allow the user more freedom of movement of the neck and head and would cut down on the tendency of the unit to sway on the user's head.	1

Comments	**No. of Responses**
The black/white contrast makes it difficult.	1
Depth perception was the only problem.	1
I thought it was really bad.	1
I would never use those in a combat situation.	1
The SMaRTS was good without the patch but when you add the eye patch, things got bad. I completed the course much faster without the patch than I did with the patch.	1
BASELINE (EYE COVER)	
A very worthwhile system.	1
Adding the eye cover allowed me to better utilize the system and have further confidence in its capabilities.	1
I can't see how it could get any better.	1
The ENVG was a very helpful system.	1
I think it is a good system that will be effective in combat.	1
If the unit will stay in place with the helmet on my head, the unit functions excellent.	1
It was fun!	1
Much better than the SMaRTS.	1
Very good system.	1
Best moving visibility thus far.	1
Clarity, brightness, and depth perception make up for everything else.	1
Preferred system over the SMaRTS for movement.	1
Heaviest and most awkward.	1

WOODLAND PATROL

SYSTEM/SAMPLE SIZE:

BASELINE (NO EYE COVER) = 29
SMaRTS (NO EYE COVER) = 30
SMaRTS (EYE COVER) = 30
BASELINE (EYE COVER) = 24

1. Using the scale below, please rate your ability to perform the following tasks with the goggle you used.

1	2	3	4	5	6	7
Extremely difficult	Very difficult	Difficult	Neutral	Easy	Very easy	Extremely easy

TASKS	MEAN RESPONSE			
	BASELINE (NO EYE COVER)	SMaRTS (NO EYE COVER)	SMaRTS (EYE COVER)	BASELINE (EYE COVER)
a. Walking through the woods	6.04	5.04	3.58	5.91
b. Walking up hill	5.79	4.96	3.42	5.83
c. Walking down hill	5.33	4.52	3.17	5.52
d. Crawling under obstacles	5.50	4.95	3.32	5.37
e. Walking through vines and undergrowth	5.21	4.57	3.08	5.39
f. Following the marked path	5.96	5.48	3.67	5.78

Comments	**No. of Responses**
BASELINE (NO EYE COVER)	
Easy.	2
I even ran with this one on. This one is awesome.	1
Extremely clear.	2
Could see most obstacles such as trees and branches on the ground and ditches fairly well.	2
These goggles made it easy to see the vines, branches, and the undergrowth in the woods.	1
I was able to follow the course well.	1
Works great for the aided eye with the unaided eye open.	1
It was rather easy to get through the terrain, but vines and branches were hard to spot and I got tangled up with the equipment (the actual scope) in a few vines several times. Other than that, the path was easy to follow and it wasn't difficult to finish.	1
The view of limbs and leaves was hard to differ from the background.	1

Comments	**No. of Responses**
I tried to anticipate a few turns and got caught up, but at no fault to the device. Path was clearly marked and the obstacles were relatively easy to navigate in the woods.	1
Easy as long as one eye is free.	1
It was easy to identify inclines but extremely difficult to identify declines.	1
It was a little bit difficult because in certain areas it was kind of hard to determine slopes.	1
Downhill is somewhat tricky and you have to stare at the ground in order to avoid falling.	1
Elevation was difficult to judge.	1
It was hard to see what was below me, so I stumbled in the little dip but other than that, I didn't have any other problems.	1
I couldn't move as fast as in broad daylight, but a lot faster than unaided. The ENVG distorted my depth perception slightly, so that I had to slow to feel the ground with my feet.	1
Following the tape was the most complicated part.	1
SMaRTS (NO EYE COVER)	
Very good.	1
Easy.	2
It was easy because I had one unobstructed eye open guiding me.	1
It was easy to follow the path because the white tape showed up very well through the SMaRTS.	1
Task was much easier due to the fact that I had an unaided eye open, and that aided in my depth perception.	1
The combination with an open eye and the SMaRTS on the other eye allowed me to switch when I needed to.	1
I saw trees unless they were either real close or farther away.	1
Was much easier this time since I didn't have that eye patch.	1
Had trouble with depth perception.	2
It was harder to walk through the woods with this system than with the ENVG system. This system had a hard time adjusting when I looked up or looked down quickly.	1
Lack of detail makes it hard to move.	1
Nearly impossible to see small vines or branches and had hard time telling the difference between shadows and logs.	1
Walking through the woods wasn't too bad. I had trouble with the vines and undergrowth.	1
To move quickly in the woods with this device you would have to rapidly focus on different aspects and pay close attention. You have to look at things "dead on" to make them stand out.	1

Comments	**No. of Responses**
SMaRTS (EYE COVER)	
Was able to complete the tasks relatively well with only the vision provided. I was more cautious this time through, and that helped in my stability and negotiation of the obstacles.	1
A lot harder with the eye covered.	1
Something about the picture makes it hard to judge distance.	1
Visual clarity was pretty low. Hard to see limbs right in front of me.	1
Could barely see what was going and judging what things were.	1
Hard to see.	2
It was hard to see the objects in my path; I had to take my time.	1
Depth perception was horrible and made it difficult to navigate.	5
This time was very difficult because now I only had one eye to look out of. I easily found holes but no thanks to the SMaRTS. I found them as I walked into them. What a surprise.	1
Everything went well until the system had to adjust to a new light level. Things got kind of fuzzy for a moment.	1
Vision gets blurry when moving fast.	1
Might have worked better if I went at a crawling pace.	1
I believe that I probably could have bear crawled faster than walking blind.	1
Easily disoriented.	1
I had a problem at one point where I got disoriented and had to stop and follow the white tape to ensure that I was continuing in the right direction.	1
It was even more difficult to detect thin vegetation. I pushed through most of the smaller bushes because I did not see them to avoid them.	1
It was extremely difficult to go through the brush. When the brush got right up close to the camera on the goggles, it was almost impossible to guide through it without losing track of where the white lined path was.	2
This task was a little more difficult. It was hard to find the vines and branches of bushes and trees.	1
It was more difficult having to depend completely on the device.	1
It was not too difficult; however, seeing what was directly in front of me was a bit of a problem, as well as the fact that terrain features were not easily recognizable through this system.	1
It stank.	1

Comments	**No. of Responses**
BASELINE (EYE COVER)	
This was the easiest system to navigate through the woods with. Everything was clear and focused.	2
Easy.	3
Tasks easily accomplished with my adaptation to the ENVG device.	1
Depth perception, which was my only problem with the other systems, was awesome with the ENVG. For some reason, I noticed a huge difference this time.	1
Depth perception was bad since the goggles magnified my vision and I had trouble moving branches or vines out of my way.	1
It was harder with the unaided eye covered. I had more difficulty with depth perception and tripped a couple of times on vines. Downhill was harder than uphill.	2
Had trouble with ditches. The only way to see them is to look down. I try to look when I'm walking and I see them.	1
I got a little turned around while following the path but found my way and got tangled up again several times in the brush.	1

2. Did you find it difficult to negotiate this course wearing these night vision devices?

	NUMBER OF RESPONSES			
	BASELINE (NO EYE COVER)	**SMaRTS (NO EYE COVER)**	**SMaRTS (EYE COVER)**	**BASELINE (EYE COVER)**
Yes	1	11	24	1
No	27	18	6	22
NR	1	1	0	1

BASELINE (NO EYE COVER)	
With the large field of vision, which allows for greater depth perception, it allowed me to quickly navigate the course successfully.	1
Course negotiation was so much easier using this device.	2
Everything was well illuminated and terrain/vegetation features were much more easily identified.	3
Very easy.	3
I saw pretty much everything on my way.	1
The course was easily navigated. Vision was perfect.	
The only annoying part was catching low hanging twigs with the NODs bracket on top of my helmet.	1
I had to be especially careful of the depressions, because the ENVG affected my depth perception.	1

Comments	No. of Responses
SMaRTS (NO EYE COVER)	
Course was easily navigated.	1
Was pretty easy.	1
Negotiating with these goggles wasn't too bad.	1
The opened eye helped.	1
Was able to effectively see the obstacles but needed to take extra time to allow the camera to come into focus.	1
I didn't really look out the goggles due to the lack of being able to see when I had them on.	1
I was a little uncomfortable and not too confident with some of my steps because of the height offset difference.	1
Can't make out details such as limbs, vines.	2
It was hard to see differences in elevation and to distinguish the difference between foot-high vegetation and vegetation flush to the ground. I tripped over quite a few vines.	1
Depth perception and sensor location create misconception and wrongful position of the foot while walking, most of the time causing me to stumble into a hole or through vines and brush.	1
Had to use unaided eye mostly to get through.	1
Lots of steep inclines.	1
It was difficult to picture the vines and undergrowth.	1
The black/white contrast is difficult to determine any objects. Some things could be viewed wrongly.	1
SMaRTS (EYE COVER)	
The course went fairly well.	1
It was not extremely difficult, but it made the task longer than it should have taken. The caution used was to adapt to the depth perception of the SMaRTS.	2
The device position threw off my depth perception and caused me to misjudge the location of obstacles. I moved more slowly because I had to pause to look around and feel obstacles with my feet.	1
Lack of depth perception.	3
The goggles continually whited out or became fuzzy.	1
There was no depth perception as the goggles continually tried to adjust to the vines and brush in front of me. The path markers were blurs at best and I was continually informed which way to go.	1
Hard to judge elevation.	1
Hard to judge distance.	1
The goggles made it hard to march through the woods. Seeing in the woods was rather difficult. I had trouble judging where logs and holes were.	1

Comments	**No. of Responses**
The picture was not very clear.	1
Hard to see; moonlight messes the vision up.	1
Yes, it was difficult because I couldn't see very well.	1
I couldn't see the first drop and some of the obstacles.	1
I was forced to focus on points instead of the entire screen to identify items and terrain.	1
If you can't see what is in front of you, it's hard to negotiate the course.	1
The only problem I had was at the one point where I couldn't tell where to go, so it took a little time to figure out where to go.	1
It was difficult when the brush got up close to my face.	1
Navigating through vines and other entanglements.	1
It was hard to see clearly. It was lot harder to notice the undergrowth in the woods.	1
It's easy to trip.	1
BASELINE (EYE COVER)	
Course was done easily.	2
Goggles worked well.	1
Relatively easy as compared to the daylight navigation of the course with the unaided eye.	1
Using the patch (cover) allowed me to focus in more with the baseline and utilize it more. This was very important because overall, I believed I moved faster doing that than when I was not utilizing it and relying more on my uncovered eye.	1
It seemed easier being able to completely focus on aided eye.	1
It was rather easy other than getting snagged in the brush.	1
The headgear strap on top got caught on a vine during the trek, but overall, it was a good experience.	1
It was easier to use the ENVG than to go completely unaided, but my altered depth perception threw me off a few times. I got disoriented once right before the course took a hard right along a narrow path and took a left before the course coach pointed me in the right direction.	1

3. Using the scale below, please rate the following characteristics of the goggle system you used.

1	2	3	4	5	6	7
Extremely bad	Very bad	Bad	Neutral	Good	Very good	Extremely good

CHARACTERISTICS	MEAN RESPONSE			
	BASELINE (NO EYE COVER)	SMaRTS (NO EYE COVER)	SMaRTS (EYE COVER)	BASELINE (EYE COVER)
a. Location of controls	5.86	5.87	5.97	5.75
b. Ability of controls to retain settings	5.97	5.87	5.87	5.83
c. Size of controls	5.66	5.83	6.00	5.58
d. Stability of helmet mount	5.72	5.50	5.53	5.50
e. Balance of goggle on helmet	5.34	5.47	5.30	5.38
f. Wearing comfort	5.31	5.47	5.43	5.21
g. Cable routing on helmet	5.81	5.88	5.81	5.71
h. Weight of goggle	5.59	5.13	5.07	5.58
i. Shape of goggle	5.76	5.33	5.30	5.71
j. Size of goggle	5.66	5.27	5.07	5.46
k. Adequacy of field of view	6.00	4.80	4.27	5.96
l. Ability to perceive depth	5.43	3.97	3.59	5.67
m. Sight picture brightness	6.14	4.93	4.83	6.25
n. Sight picture clarity	6.11	4.57	4.24	6.33
o. Overall goggle performance	6.04	4.93	4.41	5.92

Comments	**No. of Responses**
BASELINE (NO EYE COVER)	
They were perfect.	1
Goggles were light and easy to use.	1
Good clarity and contrast.	1
It works perfect for close distance.	1
It wasn't too bad. It would be worse without the NODS.	1
Bulk and weight only limiting factors. Mildly uncomfortable.	2
My ratings may have changed throughout the course of this experiment, but the larger field of vision and the adaptability of myself to use the controls allowed me to use the ENVG to its fullest.	1
I did have to adjust the focus both front and back.	1
The goggle performed well in all areas except for field of view and depth perception.	1
The size and shape of the goggles caused a few snags when it came to the actual walking through brush; other than that, it was easy to maneuver the course.	1
Hard to keep adjusting to see what's coming up and what's below you.	1

Comments	No. of Responses
SMaRTS (NO EYE COVER)	
Depth perception was so much easier since I had two eyes available.	1
Goggles work very well.	1
The goggle functions well, but the time it takes for the camera to send the picture to the viewer seems to take an extra amount of time (maybe less than a second).	1
They are fine. Not too heavy but only usable in some situations. Running through the woods is not one of those situations.	1
Depth perception is skewed.	2
Field of view is narrow.	2
It was hard to see the vines and undergrowth.	1
Lack of detail makes it almost impossible to maneuver at higher speeds.	1
Mount digs into forehead; very uncomfortable.	1
Was a lot harder than the baseline.	1
SMaRTS (EYE COVER)	
Everything was decent.	1
Goggles worked well.	1
Goggle seems good for being in an environment without obstacles.	1
I was able to see quite clearly, but as I further navigated the course, the brightness of the view changed. This took time to re-adjust to the surroundings before continuing on the course.	1
The goggles did rather well, but my vision was blurred every time I got lost on the path or lost sight of the markings.	1
The picture as a whole was a complete blur at best. There was no distinguishing any of the plant life or any depressions.	1
Depth perception was lacking.	1
The picture sight is hard to view because of the brightness and depth.	1
When moving faster, I seemed to get ahead of the device's ability to process information. I had trouble judging depth and usually slightly misjudged the location of obstacles.	1
Terrible for moving through obstacles, especially through the woods.	1
Very bad detail, even at a slow pace.	1
BASELINE (EYE COVER)	
They were perfect.	1
Everything was good about these NODS.	1
Excellent field of vision, depth perception, and brightness. Made the course very easy to negotiate.	1

Comments	**No. of Responses**
Goggles worked well and were easy to use.	2
Good system, still good contrast and brightness.	1
I had begun to adjust my eyes properly for the depth perception and thus make the system fairly complete.	1
Depth perception would be nice. Depth perception suffers with eye patch.	2
Front heavy.	1
Weight still a little too heavy and moves around a lot when you run.	1
Goggle would get tangled with branches and vines at time.	3
The I-Square knob on the front got turned off by some of the brush snagging it. Maybe put a lock on the knob so it doesn't turn itself off.	1

4. How would you describe the I2-thermal mix you used for this trial?

1	2	3	4	5	6	7
100% I^2	Mostly I^2	Slightly I^2	Equal mix	Slightly thermal	Mostly thermal	100% thermal

MEAN RESPONSE			
BASELINE (NO EYE COVER)	**SMaRTS (NO EYE COVER)**	**SMaRTS (EYE COVER)**	**BASELINE (EYE COVER)**
1.66	2.41	2.45	1.71

BASELINE (NO EYE COVER)

Clear picture and large field of vision aided in my depth perception and without the thermal, it made the navigation relatively easy.	1
I-square was pretty clear throughout the course.	2
I could see everything well. I didn't have the thermal to white out the screen when entering a dark area (like during the obstacle course).	1
The thermal helped out a little bit when moving through the woods.	1
The thermal portion definitely made it easier to spot the two Soldiers who were ahead of me.	1
The picture was completely clear - minus the depth perception - and allowed me to navigate the brush pretty easily	1
There was no need for the thermal to navigate the course, had I been on patrol looking for enemy I would have used it to help detect body heat.	1
Thermal not needed for woods.	1

Comments	No. of Responses
The depth perception was a little weird.	1
Thermal didn't really help on the course.	1
SMaRTS (NO EYE COVER)	
20/80 was the last setup that I tried and it works pretty well.	1
55/45 thermal to I-square again. This seems to be the best mix to allow my vision in the view to be most lifelike and allow for the most depth perception. Also, the polarity was set for thermal images to be black.	1
I-Square showed a good, clear picture.	1
I used mostly the I-square because it displayed objects clearer, but not as clearly as the ENVG.	1
I could see everything as long as I didn't move faster than the device could process information, but it had no depth.	1
Thermal did absolutely nothing for me.	1
SMaRTS (EYE COVER)	
55/45 thermal to I-square. I liked the mix and the brightness, and the setting of thermal images being black. This allowed for good brightness and depth perception considering the limited brightness and depth perception on the SMaRTS.	1
60/40.	1
I-square was the only helpful thing to me in this. Thermal did absolutely nothing for me.	1
I didn't notice much mix with the thermal on this course.	1
I like using the thermal when I get to use the night vision goggles.	1
It seemed to give me a good view of the ground and obstacles, just with a skewed perception of depth.	1
The ratio was 20/80 and I think that helped to see the objects more clearly.	1
BASELINE (EYE COVER)	
All I-square, and that made this task simple.	1
Didn't use much thermal on the course.	1
I-Square put off an awesome, clear image. Again depth perception was good.	1
The thermal made it easy to detect things that the night vision missed.	1
This mix worked extremely well in order to see without the thermal image whiting out the I2 when entering a darker area.	1
With 100% I-square, it was easy to see objects clearly.	1

5. Did you experience any of the following problems during this trial?

	NUMBER OF RESPONSES			
	BASELINE (NO EYE COVER)	**SMaRTS (NO EYE COVER)**	**SMaRTS (EYE COVER)**	**BASELINE (EYE COVER)**
Eye strain	0	3	6	0
Tunnel vision	2	1	3	1
Headaches	0	0	1	0
Motion sickness	0	0	0	0
Nausea	0	0	0	0
Disorientation	1	4	6	3
Dizziness	0	0	0	0
Lens fogging	0	0	0	0
Screen white-out	0	2	3	0

Comments	**No. of Responses**
BASELINE (NO EYE COVER)	
Good solid equipment. Very useful in a woodland/combat setting.	1
It was hard to see anything directly in front me on the ground.	1
SMaRTS (NO EYE COVER)	
Blurry while moving.	1
Depth perception and judging obstacles were complicated.	1
I would have had some eyestrain if I had my left eye covered.	1
The screen flashed a semi-bright light towards the beginning of the course.	1
Not a strong enough picture to have one eye focused on the screen, i.e., the unaided eye takes over.	1
Waiting time to feel out my surroundings due to small field of vision and limited depth perception, as well as time for the camera to focus when turning my head, and the screen lag of transmission from camera to video.	1
SMaRTS (EYE COVER)	
I just about fell on my face and the helmet almost came off when I tripped over some brush.	1
It would have been fine, if there was a setting for left eye dominant people.	1
Screen whites out with every hard step, such as downhill.	2
Screen white out for a brief second.	1
Eyepiece made the helmet uncomfortable to move around and it strained the eye a lot to focus through it.	1
The disorientation occurred when the brightness changed as I navigated the woods. Overall, this experience with the SMaRTS was better.	1

Comments **No. of Responses**

BASELINE (EYE COVER)

My eyes are good. 1
Depth perception was better but still a problem. 1
I was a little disoriented during the course. It was easy once again but not being used to the goggles I can't really compare. 1

5. Was there anything unsafe about negotiating the woodland patrol course?

	NUMBER OF RESPONSES			
	BASELINE (NO EYE COVER)	SMaRTS (NO EYE COVER)	SMaRTS (EYE COVER)	BASELINE (EYE COVER)
Yes	3	4	10	2
No	26	26	19	22
NR	0	0	1	0

BASELINE (NO EYE COVER)

Allowing us to move at our own pace allows this course to be extremely safe. 1
Be careful of sharp drop offs. 1
Huge holes. 1
Tripping and falling. 1

SMaRTS (NO EYE COVER)

Again, with a guide at our side, and allowing us to negotiate the course at our own pace made this course safe. 2
Can't see branches and vines so they tear your face. 1
Trees could poke out your open eye. 1
You just have to watch where you step. 1
Huge holes and sharp inclines. 2

SMaRTS (EYE COVER)

Allowing us to move at our own pace and having a guide with us allowed a safe passage through the course. 2
I guess the black-and-white view made it harder to make out obstacles. 1
Anyone could easily sprain an ankle. 1
You have to go slow or you will fall. 1
I fell down a lot, but it was because I didn't notice the undergrowth with these goggles. 2
Could not see objects in the woods unless focusing really hard on the object. Even had trouble following the engineer tape. These made me feel that the goggles made it unsafe to navigate through the woods. 1

Comments	**No. of Responses**
Lack of depth perception created problems navigating the course.	2
It's just the capability to see depth and bushes.	1
Walking through brush in the dark with one eye blind and the other one not working very well is about as smart as a screen door on a submarine.	1
With those goggles it becomes very difficult trying to identify dangers ahead of you.	1
You can't see anything until it's too late.	1
BASELINE (EYE COVER)	
Everything was good.	1
Again, allowing us to move at our own pace ensured our own safety.	1
Downhill can become dangerous when you're running.	1
Holes and sharp inclines.	1

7. Did this night vision device adversely affect your situational awareness while completing this exercise?

	NUMBER OF RESPONSES			
	BASELINE (NO EYE COVER)	**SMaRTS (NO EYE COVER)**	**SMaRTS (EYE COVER)**	**BASELINE (EYE COVER)**
Yes	2	7	13	3
No	27	21	16	21
NR	0	2	1	0

BASELINE (NO EYE COVER)	
I was able to see the trees, fallen logs, hills and drop-offs, and dangling vines extremely well and was able to negotiate the course quickly as a result.	1
Made everything easy to do and find.	1
Helped walk through it but so much focus on where you are heading destroys the situational awareness around you.	1
I had to turn my head more than I would while unaided in order to see the area around me.	1
SMaRTS (NO EYE COVER)	
Situational awareness was good.	2
Small field of vision and screen lag/focus time can be disorienting when navigating hills and drop-offs.	1
Barely any situational awareness.	1
Not being able to discriminate from something 2 feet away to 10 feet away made the course somewhat difficult to maneuver through with these goggles.	1

Comments	**No. of Responses**
Depth perception is tough to determine.	3
Goggles too heavy; can't move sight out of way.	1
I had to spend more attention on the placement of my feet and less on my surroundings than I would have liked.	1
SMaRTS (EYE COVER)	
I wasn't aware of much.	1
Nearly no situational awareness since most of my focus went to the eyepiece and trying to judge obstacles.	1
I was little aware of my surroundings beyond what I could feel and at times see up close.	1
I couldn't really tell what was going on around me after I got through the first thick pile of brush and even small branches would disorient me and send me in different directions.	1
I did not know what was going on around me just in front of me.	1
I had to pay a lot more attention to my feet to avoid falling in the ditch than I could to my surroundings.	1
I was too worried about knowing where I was going to move than anything else.	1
Made me walk slowly.	1
The limits to the depth perception and the limited field of view slowed my pace down considerably through the woods.	1
No peripheral vision.	1
Too heavy.	1
Was working too hard on seeing where I was going.	1
BASELINE (EYE COVER)	
Situational awareness was always good.	1
Yes, it made my awareness sharper in the dark.	1
Situational awareness seemed better with unaided eye being out of the situation. I felt like it was easier for my mind because it was not trying to focus two eyes that were receiving two different images.	1
I was well aware of vines and branches, except one hanging vine above my head. I was able to clearly see the hills and valleys of the course.	1
I spent more time than I would like looking at my feet, but I looked around constantly in order to keep on the path and to try to keep aware of my surroundings. A larger field of view would be nice, if it wouldn't drastically increase the weight of the device.	2

8. Any further comments concerning the night vision device you used and your ability to perform these tasks?

Comments	**No. of Responses**
BASELINE (NO EYE COVER)	
Besides the holes, it was an easy task with the baselines.	1
Great overall performance.	2
I feel that the ENVGs are the best of all the goggles.	1
It wasn't that bad at all. The white tape helps out a lot.	1
It worked well. Everything was very well illuminated.	2
The ability to quickly adjust the focus on the unit allowed me to also quickly navigate around the obstacles of the course.	2
Only problem was following tape and adjusting the goggles repeatedly to see what's around you.	1
The only problem was the depth perception.	1
SMaRTS (NO EYE COVER)	
This system was much, much better once I actually learned how to look through the NODS.	1
It's a good piece of equipment; I insist that the ENVG is better.	1
It was rather easy to do it without the patch.	1
Comfortable design.	1
Goggles work best with the use of the other eye.	1
Hard to distinguish between IR and I-squared.	1
With the patch on my eye it was like being blindfolded.	1
I could see pretty well but not as good as the baseline.	1
It needs more brightness and color.	1
Just the holes and the sharp inclines.	1
No detail.	1
Screen is useless while moving.	1
Not good for movement through woods like the baseline.	1
Harder to see with than the ENVGs.	1
When using this device, I tended to rely more on my uncovered, unaided eye to balance myself and allow for greater depth perception. It does seem to be a normal tendency to not use an eye if you cannot see through it.	1
SMaRTS (EYE COVER)	
Comfort is good, sits fairly well on head.	1
I-Square was clear and my visibility was good.	1
I am now able to secure the unit to my head much better and I am better adapting to the controls and the much smaller view. However, I still cannot see my feet to orient myself to my surroundings.	1

Comments	**No. of Responses**
Depth Perception, Depth Perception, Depth Perception. That was the only problem. Everything else was good. I just couldn't tell whether the ground was level or if there was a giant hole right in front of me.	3
Clarity is horrible.	1
Unable to distinguish between open space and the sticker bush in front of you.	1
Contrast is a no-go.	1
Not a good unit to move through the woods.	1
Once again, I would rather have nothing in a battlefield environment than these goggles.	1
The ground looks like black and grey fuzz.	1
Yeah this wasn't so fun.	1
BASELINE (EYE COVER)	
All was great on this run.	1
The goggles worked well and I had no problems.	1
Is easy to run around with this one cause you can see pretty much everything on your way.	1
I think my preferred device would be the ENVG because it is more of a clear relayed picture, rather than a camera transmission to a view in front of your eye. The clear, relayed picture seems to be instantaneous, rather than the delay of the SMaRTS.	1
I like the NODs the best.	2
I think with some work the others can perform to the standards of the ENVGs.	
Overall, the system was a great aid to my movement through the brush and vines.	1
Very effective at a moderate pace; the faster you move, the more problems occur.	1
For this exercise it did not make a noticeable difference with or without the eye patch.	1
With one eye completely closed, my situational awareness was sacrificed.	1
I saw everything very well, except some of the thorn vines that caught me in the face.	1
Just emphasize about the knob being turned by the brush. I had to turn it back on to be able to complete the obstacles.	1

TARGET LASER COURSE

SAMPLE SIZE = 30

1. Using the scale below, please rate your ability to perform the following tasks with the goggle you used.

1	2	3	4	5	6	7
Extremely difficult	Very difficult	Difficult	Neutral	Easy	Very easy	Extremely easy

TASKS	MEAN RESPONSE		
	BASELINE ENVG	SMaRTS	BRASSBOARD
a. Finding targets at 25 meters	6.37	5.73	3.10
b. Finding targets at 50 meters	6.33	5.03	2.53
c. Finding targets at 100 meters	5.30	3.60	1.93
d. Lasing targets at 25 meters	6.37	5.37	3.03
e. Lasing targets at 50 meters	6.20	4.73	2.34
f. Lasing targets at 100 meters	5.27	3.20	1.90

Comments	**No. of Responses**
BASELINE ENVG	
Easy.	3
Great goggles.	1
Easy to find and "lase" targets. Visibility was great.	8
Perfect clarity.	1
This system is the most appropriate for the task.	1
This was a lot better than the brassboard.	1
100-meter target difficult to see.	4
Could see 100 meters prior to my turn at aiming it, but when I went into the kneeling/ supported (position), I was unable to find it.	1
Around the edge of the goggle the vision got a little blurry.	1
Being left eye dominant, it was a little harder doing it with my right eye.	1
SMaRTS	
Easy.	2
I was able to successfully find and lase the target even with the fog.	1
I had difficulty finding the 100-meter target but other than that, I was good.	1
Missed lasing target on 50 meters only because I was not adjusted to the technology. Once adjusted, equipment was fine.	1

Comments	**No. of Responses**
Locating farther 100-meter target easier than locating the 50-meter target; 25-meter target was easy to spot.	1
I could not find the 100-meter target.	7
A fog was there which hindered the ability to see clearly at the 100-meter target.	1
I had a very hard time seeing the 50- and 100-meter targets with this system.	2
Its gets hard to see the long-distance targets.	1
A little difficult to see.	1
Blurry.	2
It was hard for me to see, being left eye dominant, using a right-eye-only system.	1
The target was off by at least 10 meters up.	1
BRASSBOARD	
Easy.	1
It was easy to find the target but the scope was on the wrong eye so I couldn't aim normally.	1
Can't see anything farther than 20 meters.	1
Can't see too much besides dark spots, which got lased.	1
It was hard to make sense of the brassboard information mixed with my vision. It was hard to even see the targets at all. I had to close my unaided (dominant) eye in order to see the laser because my brain started to ignore the brassboard information.	1
Extraordinarily difficult finding and pointing at targets, tough to see anything.	12
Missed on 50-meter target due to target and person standing next to target. Thought person was actually target -- difficult to differentiate -- just two dark masses.	1
Could not acquire targets for 50 meters well, and could not see 100 meters whatsoever.	2
Hard to see 100-meter target due to vision quality.	1
Depth perception difficult.	1
I could only identify the tree line and objects nearer than 5 meters.	1
I had a very hard time learning how to properly look through I-square.	1
Image was fuzzy.	1

2. During this trial, did you use mostly I2, mostly thermal, or an equal mix of the two?

1	2	3	4	5	6	7
100% I^2	Mostly I^2	Slightly I^2	Equal mix	Slightly thermal	Mostly thermal	100% thermal

BASELINE ENVG	SMaRTS	BRASSBOARD
1.50	1.52	1.79

Comments	**No. of Responses**
BASELINE ENVG	
I-square 100% is my preferred method of finding targets and wearing an aiding device.	1
I liked having the 100% I-square ratio; it made the targets very clear.	3
I saw pretty well with the mix.	2
It worked great.	1
SMaRTS	
Having some thermal would have definitely helped me locate the targets more easily.	1
I-square.	1
Real grainy.	2
The SMaRTS goggle is much more efficient when only using the I-square feature and no thermal. The blur that occurs when turning your head quickly to focus on an object is considerably less than with any sort of thermal mix.	1
BRASSBOARD	
Good mix.	1
Had I been able to focus properly through the I-square, everything would have been pretty clear.	1
I-square was not clear at far ranges.	1

3. Did you experience any of the following problems during this trial?

	NUMBER OF RESPONSES		
	BASELINE ENVG	SMaRTS	BRASSBOARD
Eye strain	1	4	7
Tunnel vision	1	2	0
Headaches	0	0	3
Motion sickness	0	1	0
Nausea	0	1	0
Disorientation	1	2	3
Dizziness	0	0	0
Lens fogging	1	0	0
Screen white-out	0	0	1

Comments	No. of Responses
BASELINE ENVG	
Due to my being left eye dominant and using right eye.	1
My eyes were great.	1
No problems since the mist had completely subsided.	1
Very slight lens fog.	1
SMaRTS	
Good overall system so long as steady position can be achieved.	1
Can see the squares the image is made up of.	1
Caused by my left eye dominance.	1
Felt that I had to really focus on screen when image was presented.	1
It was hard to find or hit the farther targets with only I^2 to guide me.	1
Only problem seemed to be mother nature and the fog that she seemed so fit to grant us when trying to acquire and lase the 100-meter target.	1
BRASSBOARD	
Couldn't see anything.	1
The targets were not visible on the screen.	1
Gets very blurry with slight movement.	1
The picture seemed to go in and out of focus. It could have been just me, I'm not sure.	1
Not a very defined picture.	1
The bladder was pumped so full that it felt extremely hard.	1
The fixation for the 50-meter target took longer than the 3 seconds given to lase.	1
Unit would not sit properly on my head, and turning changed where I was looking. It did not allow me to visually acquire targets beyond 50 meters.	1
The system was well aligned to my eye initially, but spinning around apparently caused the unit to start to slip forward. It was hard to make sense of a black-and-white image mixed with the image from my other eye.	1
Very disoriented with this one.	1

4. Was there anything unsafe about mounting the weapon sight to the weapon?

	BASELINE ENVG	SMaRTS	BRASSBOARD
Yes	0	1	2
No	28	27	26
NR	2	2	2

Comments	No. of Responses
BASELINE ENVG	
Nothing.	3
SMaRTS	
Tripping and falling.	1
BRASSBOARD	
Couldn't see anything.	1
Tripping, falling and running into obstacles.	1

5. Did this night vision device adversely affect your situational awareness while completing this exercise?

	BASELINE ENVG	SMaRTS	BRASSBOARD
Yes	3	6	11
No	27	23	18
NR	0	1	1

Comments	**No. of Responses**
BASELINE ENVG	
Excellent situational awareness.	1
Made everything easy, better.	2
When turning and facing the targets, there is no vision blur, and I am able to completely acquire and lase the targets effectively. There is a much greater advantage with having absolutely no vision blurring when turning to face the targets.	1
Aware as can be.	1
Need to be more focused on the 100-meter target.	1
SMaRTS	
My vision was good.	1
Situational awareness was good.	1
I was able to acquire and lase the targets effectively when only using the I-square feature of the SMaRT goggle.	1
Had trouble acknowledging targets past 50 meters.	1
It took an extra second to identify the 100-meter target. It is difficult to make out shapes at that range.	1
The ENVG could get closer and I would be in trouble.	1
The graininess messed up the vision.	1
BRASSBOARD	
Bulky backpack.	1
Can't see the targets and that's not what we are looking for.	1
Couldn't see anything.	1
Not clear on what I was aiming at.	1
I don't think I could have defended myself at all against an enemy at those distances. For most of the shooting exercise, I was for all practical purposes blind.	1
I spent too much time trying to find the view picture than finding and lasing the targets in question.	1
Unable to identify targets at greater distances (50+ meters).	1
Would have been completely combat ineffective if I had to rely on my situational awareness with the brassboard.	1

6. Using the scale below, please rate your ability to perform the following characteristics with the goggle you used.

1	2	3	4	5	6	7
Extremely difficult	Very difficult	Difficult	Neutral	Easy	Very easy	Extremely easy

CHARACTERISTICS	MEAN RESPONSE		
	BASELINE ENVG	SMaRTS	BRASSBOARD
a. Location of controls	5.93	6.03	3.96
b. Controls to retain settings	6.00	5.97	4.33
c. Size of controls	5.77	6.21	4.19
d. Stability of helmet mount	5.93	5.93	3.62
e. Balance of goggle on helmet	5.67	5.62	3.70
f. Wearing comfort	5.47	5.66	3.87
g. Cable routing on helmet	5.86	5.92	3.65
h. Weight of goggle	5.80	5.21	3.97
i. Shape of goggle	5.87	5.29	4.03
j. Size of goggle	5.90	5.17	3.63
k. Adequacy of field of view	5.97	4.79	3.17
l. Ability to perceive depth	5.79	4.71	3.07
m. Sight picture brightness	6.17	5.34	3.13
n. Sight picture clarity	6.21	5.07	2.63
o. Overall goggle performance	6.21	5.00	2.77

Comments	**No. of Responses**
BASELINE ENVG	
System worked great. Finding and lasing targets was very efficient.	2
Clarity and depth perception are good; contrast is excellent.	1
Easy to use and quick to learn. After using them a few times I feel like I could use the ENVGs comfortably in a combat situation.	2
ENVG did much better for me this time.	1
Good goggles.	1
Goggles are excellent as long as you are not in movement with them.	1
I still think that the larger field of vision is very important as well as clarity of picture. Of course, if the unit still moves around and you cannot even see through the viewer, then none of those matter.	1
My only complaint about the baseline system is the lens cover that sometimes hangs and hits my face.	1
Weight is top/front heavy, uncomfortable for longer time periods.	1
SMaRTS	
Easy to use.	1
Was very comfortable.	1
Good.	1
I like this system. It seems easy to adjust as long as you aren't moving it. It's very helpful for night aiming and shooting.	1

When the thermal feature is not in use, this goggle is a much better tool and is not a hindrance in acquiring and lasing targets. The I-square feature would be much enhanced if the field of view would be greater.	1
Blurry; couldn't see 50/100 meters.	3
It gets to blurry once you pass the 50-meter target.	1
Bounces around too much.	1
If the model could be switched to the left eye, it would be fine for someone like me.	1
It could be made smaller.	1
The weight of the system didn't give me any problems when spinning around.	1

BRASSBOARD

Could not see very much at all.	1
Blurry.	1
The system was very loose on my head and I could hardly see anything, let alone the targets with this system.	1
I didn't really like the way that it positioned onto my head. It felt like there was a lot of room to move around. I think that the bladder, when it is pumped up, takes up too much room and doesn't allow the helmet to properly fit onto the head.	1
I don't like wearing this and it is hard to see.	1
It has a bad picture that doesn't line up with the unaided eye very well at all.	1
Light and darkness contrast seem to change abruptly while using it.	1
No controls available and clarity needs to be better.	1
Not suitable for field use, impossibly hard to keep screen centered on eye, no clarity or contrast, everything seemed to blend together.	1
The helmet slid forward after the first time that I turned around to shoot. We had the air bladder and the straps adjusted very tightly, but the motion apparently caused it to shift. But even when it was properly oriented, I had trouble seeing the target.	1
They didn't really let me touch the controls but the scope was easily adjustable to my eyes.	1
Too heavy and poor vision.	1
Unit needs much work to allow for a better fit, larger field of vision, and a more clear display.	1

7. Please comment on any areas concerning the night vision device you used and your ability to do these tasks.

Comments	**No. of Responses**
BASELINE ENVG	
Best goggle system tested.	3
Good clarity and contrast.	1
Could see everything very well.	2
Overall very sound technology.	1
The baseline performed very well as an aid to identifying targets at great distances.	1
Easy to use and quick to learn.	1
The night vision made shooting the targets easy.	1
Would rather have the SMaRTS for recognizing targets from a distance but situational awareness is better with the baseline even though only true problem was acknowledging the 100-meter target when I went into the kneeling position.	1
Best tool here because of the largest field of vision, once the helmet is completely secured to my head.	1
The sweatband was adjusted, so this helmet fit very nicely and that made my view through the lens very clear. If the sweatband had not been adjusted, it would have been difficult to see through the lens well.	1
Prefer green to white/black.	1
Size, weight, and bulk are the limiting factors with this unit.	1
Finding the 100-meter target was a little bit of a challenge.	3
The knobs turning in opposite directions for on or off are a problem.	1
SMaRTS	
Overall, I believe this system is superior with its I-square than that of the baseline and the brassboard. It was much easier to identify the targets at all ranges.	1
Goggle functions great. I like the I-square feature of this goggle, and if the field of vision were greater, I would replace the ENVGs with this tool.	1
A decent design; however, I feel that the ENVG is better. The SMaRTS performed well for the lasing but the clarity of the I-square wasn't so good.	1
Takes too long to adjust or focus.	1
I didn't much like the laser pointing but it did well for the purposes of this exercise. I felt like it would be better for all training purposes, obviously, if we were doing a live fire exercise with the ENVGs and SMaRTS.	1
After spinning around, there was an initial period of disorientation until I could make sense of the image. That completely threw me off on the first shot (at the 50-meter target).	1
Any extremely bright light, such as flashlight or looking directly into the moon made everything go black except anything that was near the vicinity of the light. Did not have this problem when aiming at targets.	1
I saw everything fine except the 100-meter target.	1
I think that adding a color to the system would help immensely. The black and white just doesn't cut it.	1
If I have got more practice at night shooting and wearing the goggles, I think I would have shot better.	1
Offset of camera makes target acquisition difficult.	1

PAC-4 placement made it difficult to achieve steady position which may have affected results; goggle system was good once steady position was assumed.	1
Really blurry.	1
System worked well except at 100-meter target.	1

BRASSBOARD

Seems like a good idea once all the kinks are finished.	1
Brassboard is heavy, slides around on the head, and provides horrible picture output. No detail, no depth perception, and very difficult to use and move in.	1
Couldn't see anything, it was all dark.	1
The helmet doesn't fit very well, but other than that, the night vision works very well.	1
Helmet slipped forward.	1
The sighting was off to the left, and try as I might, I could not get the sighting correct because of the size of the helmet, how it sat on my head, or the ability for the screen to rotate correctly; I could not get it right.	1
I couldn't really tell where the targets were at first. It took me a moment to guide the laser due to the scope being on the left eye rather than the right, which is my dominant eye.	1
Would have been a lot better to be able to use my dominant eye.	1
It is very difficult to see even the outlines of the targets. The amount of illumination had decreased somewhat since the first time I used this device. It appeared to have a more detailed image with the reduced illumination.	1
Not a proficient piece of equipment.	1
Uncomfortable and the screen seems to have a problem with light and dark which changed repeatedly while I'm wearing it.	1
The second trial with the brassboard was much better than the first, but it was still the worst of the three.	1
The system needs two people to adjust it. That makes it hard to finely adjust any of the settings, if at all. Also for how cumbersome the system is, there are no benefits to having the extra weight.	1

MOUNT/DISMOUNT AIMING LIGHT

SYSTEM/SAMPLE SIZE:

BASELINE ENVG = 29
SMaRTS = 30
BRASSBOARD = 30

1. Using the scale below, please indicate the level of difficulty completing the following tasks.

1	2	3	4	5	6	7
Extremely difficult	Very difficult	Difficult	Neutral	Easy	Very easy	Extremely easy

TASKS	MEAN RESPONSE		
	BASELINE ENVG	SMaRTS	BRASSBOARD
a. Attach the aiming light to weapon	4.93	3.43	2.17
b. Remove the aiming light from weapon	5.85	5.28	3.63
c. Adjust the night vision system to see close in objects	4.79	3.48	2.13
d. Confirm that the sight was attached solidly	5.86	4.86	3.32

Comments	**No. of Responses**
BASELINE ENVG	
The tasks were very easily completed.	1
This task was super easy to do. These night vision goggles were the best to work with.	1
Was able to function to complete the task while wearing these goggles. I could rely on this device while completing this task.	1
Detail easy to discern, view at eye level made for good hand-eye coordination.	1
Was able to see everything very clearly.	1
Easy to accomplish task, although a lot of it was still accomplished by touch rather than sight.	2
Sometimes it's easier to feel around than to look.	1
Close up was very blurry.	5
I was able to see the weapon and light from a medium distance, but it was hard to work with them close up.	1
It was difficult to place the aiming light on the weapon; it looked like a blur.	1
Couldn't see the hole.	1

Comments	No. of Responses
Had to rely on the unaided eye still because the goggles seem to have magnified my sight and cause bad depth perception.	1
Hard.	1
It is easy to detect targets at arms length by outline. There is little to no detail however.	1
My lack of training in full light and practicing a few times made it difficult to identify what needed to be done throughout the attachment process (this was a factor in all three cases).	1
SMaRTS	
It was a lot easier to assemble the laser sight onto the weapon with the SMaRTS than it was with the other two.	1
The auto-focus feature of the camera worked excellently in this situation. I was able to see the objects relatively clearly to complete the task.	1
This task would have been more difficult had I not just done it. I was able to detect the objects up close with similar clarity to the ENVG. Mostly outlines with little detail.	1
This was better to work than the brassboard.	1
During task could see very little but the task completed fairly easy.	1
Rather easy but I'd never used that system before so it took a little time.	1
Because of the placement of the camera, it was difficult to complete this task. I had to raise the light high up to see it and look far down to attach it to the weapon.	1
Difficult to see detail, performed the task mostly by feel.	1
I did most of this test by feel as I could barely move my head to see close in. I did not make any "close in" adjustments in the goggles. Very hard to make out small details such as screw mounting.	1
It was very hard for me to see up close. Everything was black and fuzzy. The only thing that I had an idea of was my hand. To take the aiming light off, I did it by feel.	3
It was easy to see the objects at first, but once I was focused on an object for a little while, it went out of focus and was difficult to see.	1
Had some issues dealing with the equipment up close. The objects were too dark.	1
Easier to see but had to hold the rifle in an uncomfortable position to actually be able to look at it.	1
I was unable to attach the light to the weapon because I had an extremely hard time coordinating my hand and eye while using the equipment.	1
My depth perception was off.	1
Obstacles too high up. You have to bring the weapon up over your eyes to see it.	1
Taking off the light did not require you to use the SMaRTS. Goggle wouldn't stay centered and my vision was obstructed.	1
Very hard.	1
BRASSBOARD	
The goggles actually helped a little bit for the unscrewing and assembly.	1
All I saw was black with some white dots.	1
All the assembly and removing was pretty much by feel.	1
Could barely see anything in close.	5
Low visibility with close objects.	1
I could only see grainy blurs.	1
Could not complete at all. Very difficult to see.	1
Could not see in any detail.	2

I was unable to complete the task because I could not see the laser on the table. I could barely see the outline of the weapon and the graders.	1
Sight moved around and would go back so I could see.	1
Difficult to see and establish hand-eye coordination.	1
Due to the fact that my vision was completely impaired, I could not rely on the vision provided by the brassboard. My hands were blurry and I could not see anything on the rifle or the aiming light.	1
I had to complete this exercise completely by feel.	7
Most of the tasks were completed by feel based on the fact that the lack of detail made it impossible to properly line up the weapon and aiming light.	1
Hard to distinguish any detail at any distance.	1
I had near zero clarity with the goggles. Took a while for picture to adjust after any light was turned off.	1
I was unable to even see the laser sight or the weapon through the brassboard. I was unable to complete this task within 2 minutes.	1
It was very hard to attach the light to the M4.	1
Too dark.	1
Very hard.	1

2. During this trial, did you use mostly I2, mostly thermal, or an equal mix of the two?

1	2	3	4	5	6	7
100% I^2	Mostly I^2	Slightly I^2	Equal mix	Slightly thermal	Mostly thermal	100% thermal

BASELINE ENVG	SMaRTS	BRASSBOARD
1.17	1.38	1.82

Comments	**No. of Responses**
BASELINE ENVG	
With 100% I-square, it was easier to see the weapon and the laser light.	1
I believe close up the ENVG has the better I-square capabilities compared to that of the brassboard and the SMaRTS.	1
Was hard to see things from up close. I don't think that I had the NODS properly focused.	1
I could see far away, but not close up very well.	1
No thermal required due to lack of heated object other than my hands.	1
No thermal.	1
The thermal always helps the night vision to catch things you didn't see with the night vision.	1
SMaRTS	
100% I-square for the exercise allowed for best vision in the situation.	1
Didn't use thermal.	2
I could see fine with this mix. It was just hard to coordinate my movements with my vision.	1
I was able to focus the I-square pretty well and was able to complete the task in a timely manner.	1
BRASSBOARD	
I don't know what the mix was for this device.	2
I noticed it is a lot easier to see using the mix versus just the I-square.	1
I noticed that when you are trying to focus on something very close, the brassboard is the wrong system to use.	1
Night vision is totally inadequate. I could not focus on objects close up and my vision was completely blurry.	1
Don't like the lack of control for operator.	1
The thermal mix didn't really affect the assembly but I noticed it in use.	1

3. Did you experience any of the following problems during this trial?

	NUMBER OF RESPONSES		
	BASELINE ENVG	**SMaRTS**	**BRASSBOARD**
Eye strain	1	3	4
Tunnel vision	1	1	3
Headaches	0	1	1
Motion sickness	0	0	0
Nausea	0	0	0
Disorientation	2	2	4
Dizziness	0	0	0
Lens fogging	0	0	0
Screen white-out	0	0	1

Comments	**No. of Responses**
BASELINE ENVG	
Had to strain eyes to focus on the rifle.	1
I couldn't get the NOD to be as precise up close.	1
I was totally unable to attach the light to the rifle.	1
No other problems existed. Auto-focus would be a plus here but not quite necessary for this task.	1
Not bothered by the goggles.	1
SMaRTS	
Other than a small field of vision, and depth perception still decent, the task went well.	1
Received a headache cause by possibly straining my eyes trying to see everything.	1
The screen was becoming fuzzy, and there were a lot of little black dots.	1
BRASSBOARD	
Couldn't see a thing.	1
Depth perception was poor.	2
Eyestrain due to poor picture quality.	1
It was difficult to grab the aiming device after picking up the rifle.	1
No real problems, except the vision being blurred.	1
The screen seemed to go blank at close range (all black).	1

4. Was there anything unsafe about mounting the weapon sight to the weapon?

	BASELINE ENVG	**SMaRTS**	**BRASSBOARD**
Yes	1	1	2
No	26	29	28
NR	2	0	0

Comments	**No. of Responses**
BASELINE ENVG	
Bad muzzle awareness and had trouble making sure it was properly secured.	1
It was too easy to get hurt.	1
SMaRTS	
No safety hazards here.	1
It was too easy to get hurt.	1
Terrible muzzle awareness.	1
BRASSBOARD	
I felt like the helmet was going to fall off my head when I was looking down.	1
It was too easy to get hurt.	1
No muzzle awareness or any idea where the rifle was. I was completely relying on unaided eye and touch.	1

5. Did you find it difficult to grasp objects close-in while performing these tasks?

	BASELINE ENVG	**SMaRTS**	**BRASSBOARD**
Yes	5	17	21
No	22	13	8
NR	2	0	1

Comments	**No. of Responses**
BASELINE ENVG	
Very easy.	1
I could see clearly.	1
It was easy to see the objects with this system and therefore easy to grasp the objects.	1
Yes, depth perception is somewhat difficult and clarity is not 100%, still much better than other units used.	1
Depth perception and brightness were adequate enough to visually discern between objects while doing this exercise.	1
I didn't have much trouble at all deciphering where the laser needed to be positioned on the mount. This cut my time a full minute.	1
Depth perception was bad but not very bad.	1
Bad depth perception.	1
Couldn't attach the laser because it was hard to find the hole on the gun.	1
Hard to see. Very blurry.	2
It isn't difficult to grasp objects, but it was really hard to see to manipulate them right.	1

Comments	No. of Responses
SMaRTS	
I was clearly able to see the objects, especially since I did not have to move my head or the camera mounted to my head. I was able to focus and attach the object with ease.	1
Easy, but I could have done it with my eyes shut, too.	1
Could barely see a thing.	2
Depth perception was all screwed up.	3
Fuzzy image.	1
I couldn't find the hole for the laser on the weapon at the beginning.	1
I found it difficult to see the objects. The object did not present itself easily closely.	1
It was hard to see close details.	2
I had a little bit of a hard time grasping the aiming light to affix it to the rifle.	1
It was easy to grasp, but actually seeing it while I was grasping it was a different story.	2
It was hard to manipulate the objects properly in order to attach them.	1
Poor hand-eye coordination.	1
The helmet felt top-heavy while looking down. I had to put my chin on my chest just to see what I was doing.	1
BRASSBOARD	
It was hard for me to find the laser flap on the actual laser, but once I did that, assembly was easy.	1
Easier to see my hand than the M4.	1
Could not see them.	6
I was able to see the components better from about 10 feet away than I was standing over them.	1
Detecting them made it difficult to grasp.	3
Depth perception gone.	4
No detail to see where to align weapon rail and aiming light.	1
Forced to use feeling technique.	2
Extremely difficult.	1
Image was fuzzy and dark.	1
It was hard to find the place to attach the laser to the weapon.	1
Nearly zero on the focus, and nearly zero on the brightness. Not only difficult to see the objects, but I had no bearings.	1
Offset did not promote good hand-eye coordination.	1
Things seemed closer than they were.	1

6. Please comment on any areas concerning the night vision device you used and your ability to do these tasks.

Comments	**No. of Responses**
BASELINE ENVG	
Everything worked well.	2
I love the night vision goggles.	1
Excellent use of this device. If it ain't broke, don't fix it.	1
The baseline was perfect. I could see everything and my depth perception was good.	1
Best overall unit.	2
Clarity and contrast far surpassed the other units.	1
Used sight almost as much as touch with this device, whereas the other goggles forced me to use 90% touch due to lack of detail and contrast.	1
Close up I believe the ENVG is the best of the three systems.	1
Could see the weapon and system completely.	1
Adjusting the sight might take a while. Once you've been adjusted, it's easy.	1
Was more effective than the brassboard.	1
Had trouble judging perception with goggles.	1
Hard to focus on objects close up.	2
SMaRTS	
Overall in the three trials for this task, I was most impressed with this one. It gave off the clearest image.	1
The goggles worked fairly well.	1
Probably the easiest of the three but was not that much better.	1
It helped a little but not a lot.	1
A clear field of vision and greater detail in the field of vision would have improved this task greatly.	1
Could take some getting used to.	1
Extremely difficult to see.	1
Hard to distinguish any detail up close with these goggles.	1
Night vision helps but if I weren't cutting colored wires, then I'd mainly use my sense of touch.	1
No fine detail so attaching the PAC-4 was challenging, most of it was accomplished by feel rather than relying on the goggles.	1
Once again to have the helmet tight enough, the display is too low at its highest point.	1
BRASSBOARD	
All good except from my depth perception.	1
It was hard to decipher the actual laser in the goggles. I couldn't see which way was forwards or backwards on the laser but after I got it straight, I was good.	1
It is a horrible system.	1
As soon as I looked down to try and view the weapon, the entire goggle system slid down so that it was out of focus.	1
I had to go by feeling almost entirely because the goggle system was more a hindrance than a help.	1
I could not rely on the device to complete the exercise. I had to mount the aiming light completely by feel and not by sight. I even completely closed my eyes while doing the task and it allowed my disorientation to be lessened.	1

I was unable to complete this task simply because I couldn't even see the parts to assemble.	1
It was extremely difficult to see with the brassboard. I continually saw what can be described as shooting stars and the light intensity was to the point where it was almost as dark as seeing it with the naked eye.	1
Need better close sight.	1
The test was impossible to complete relying on the goggles.	1
This system makes it very difficult to complete a task in the pitch dark.	1
When I looked down, the display showed all grainy or "snow"; after about 30 seconds, I could see again but only my hands were clear.	1
Yeah, I don't like the brassboard that much.	1
You could hardly see anything you were doing.	1

END OF EXPERIMENT

Please provide your comments on the night vision device you used during the woodland IMT course.

Comments	**No. of Responses**
BASELINE	
Adequate for testing.	1
After using both systems, I prefer the baseline unit in comparison with the SMaRTS. During the course I found that when I relied solely on the system, I could see and perform a great deal better than when I would use it half the time and other open eye.	1
Baseline was better because you could see everything very clearly.	1
Baseline was far better than the SMaRTS in every way.	1
Baseline wins, hands down because of real visibility.	1
Baseline worked twice as well, was able to pick out branches and vines and holes in the ground.	1
Easily navigated with the baseline ENVG.	1
I could see with greater accuracy my surroundings, with better depth perception, brightness of vision, and a large field of view.	1
I prefer the ENVG because they actually show a little color, and with a little color, it's easier to tell the different depths. This in turn makes it easier to move through the course at a higher rate of speed.	1
It was fun.	1
The baseline was the only one clear enough to navigate fairly smooth.	1
The baseline gave you the ability to clearly see everything ahead of you while at the same time leaving your uncovered eye able to see using your natural night vision abilities.	1
The course was a good experiment for the night vision goggles. The base model gave the best depth perception and outline of the environment.	1
The course was very well set up for testing these goggles. I think that the baseline performed the best.	1
The devices threw off my depth perception, but the ENVGs were the easiest to use.	1
The ENVG worked a lot better than anything else. I could clearly see the obstacles in front of me.	1
SMaRTS	
It was easier to tell what the obstacles were with the SMaRTS and it seemed to not bounce around or lose focus as much as the baseline.	1
Lacked proper depth perception.	1
SMaRTS didn't have the clarity or contrast to keep up.	1
With the SMaRTS, it was almost impossible to see the line while going through the brush.	1
Had to be taken one step at a time because of depth perception and clarity.	1
Very difficult to use the SMaRTS.	1
GENERAL	
It's a good course that gives glory to ENVG and disgraces SMaRTS only when one eye is covered.	1

Lots of thorns and vines.	1
You can actually run with the ENVG but you can just range walk with the SMaRTS.	1
The negotiation of the course was faster with the baseline than with the SMaRTS.	1
It was rather easy when I didn't have the eye patch on, but when I had the ENVGs on it was a lot easier to navigate the course because the line was visible.	1

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